SÆRTRYK

af „Danmarks Havebrug og Gartneri til Aaret 1919"

Arbejder fra Botanisk Have i København Nr. 93

BOTANISKE HAVER

AF

BOTANISK GARTNER AXEL LANGE

DEN Interesse, man i gamle Dage nærede for Planterne som de fornemste Lægemidler, har uden Tvivl foraarsaget, at Lægerne for ret at kunne siges at forstaa deres Videnskab maatte give sig af med Botanik, og det var da ikke underligt, at man søgte at skabe Plantesamlinger, hvor Studiet af saavel vildtvoksende som dyrkede Urter kunde ske i Ro og Mag, og hvor Planterne var helliget dette Formaal alene. Ligeledes er det forstaaeligt, at Institutioner eller Privatpersoner efterhaanden som Kommunikationen med fremmede Lande forbedredes og Kendskabet til disse øgedes, fik Lyst til at prøve Dyrkningen af disse fjærnere Landes Planter.

Nogen Efterretning om botaniske Haver har man ikke førend en Menneskealder ind i det 16. Aarhundrede. Det har ofte været tillagt Universitetet i Padua Æren af at have stiftet den første botaniske Have — anlagt 1545 — men Eichhorn mener dog i sin „Geschichte der Literatur" (I, S. 304), at Euricius Cordus allerede i 1534 i Marburg anlagde en privat botanisk Have. Uden Tvivl er Universiteterne dog gaaet foran i denne Bevægelse og først senere er det blevet almindeligere, at Fyrster, Kommuner eller private Personer har taget Tanken op. Bolognas Universitet fik i 1568 sin botaniske Have og Leydens Universitet kom efter i 1577, medens Aarhundredet skulde løbe til Ende, før vi her i Danmark kunde glæde os ved Besiddelsen af en saadan Anstalt.



Fig. 123. Plan over Universitetskareen med Botanisk Have. 1757.
A. Auditorium. B. Botan. Have. C. Konsistorium. 247. Professorbolig.

KØBENHAVNS UNIVERSITETS FØRSTE BOTANISKE HAVE
(HORTUS MEDICUS)

I Aaret 1600 skulde der bygges en ny „Residentz“ i Studiegaarden som Bolig for en af Professorerne, og det blev da besluttet, at et Jordareal, „220 Fødder i Længden og 110 Fødder i Bredden“, hvilket fra først af havde været bestemt til Opførelse af Enkesæder for Præsteenker, skulde udlægges til en botanisk Have. I et „Kongeligt Skiøde og Gave-Brev“ af 2den August 1600 læser vi: „Og efterdi fornævnte Plads udi saa lang en Tiid haver lagt øde, og ikke derpaa er faaet nogen Bygning; Saa og efterdi Universitetet der udi fornævnte vor Kiøbstæd Kiøbenhavn er med en nye Residentz blevet forbedret; Thi have vi naadigst undt, skiøt og givet, og nu med dette Vort aabne Brev unde, skiøde og give formeldte Plads til Universitetet der sammesteds, saa det altid herefter skal ligge og bruges til en Have til formeldte Residence, hvorudi kan ympes og plantis synderlige Simplicia, og skal den Professor, som i formeldte Residentze bliver boendes, dermed have Opseende.“

Haven laa ud mod Skidenstræde — den nuværende Krystalgade — omtrent paa den Plads, hvor nu Zoologisk Musæum ligger. Der blev ikke bevilget Midler til at holde Haven, *hortus botanicus* eller *hortus medicus*, vedlige med; „thi da man af førstningen formodentlig allene har tænkt deri at indtage vores vilde Planter, har man troet, at dertil ingen Udgifter behøvedes og derfore ey heller tillagt den Indkomster“ (Rottbøll). Der var heller ingen Urtegaardsmand eller Gartner ansat derved; den Professor, som fik tildelt Embedsboligen, maatte tillige vedligeholde Haven og af egen Lomme betale de paaløbende Udgifter. Det har ikke al Tid været de medicinsk-bo-

taniske Professorer ved Universitetet, som har faaet Boligen tildelt og dermed Forpligtelsen til at have Tilsyn med Haven, hvilket vilde have været rimeligt, men de Professorer, som benyttede Haven, har sikkert haft en vis Indflydelse paa Driften.

Den berømte Ole Worm har i sin Tid haft Haven under sig, ligesaa har Rasmus Caspar Bartholin haft den i sin Varetægt. Sidstnævnte nærede saa megen Interesse for den, at han skænkede 1200 Kronedalere til et Legat (stiftet 5. Dec. 1696, konfirmeret 8. Nov. 1698), „hvoraf dend Aarlig Rente skal bruges til hielp at holde

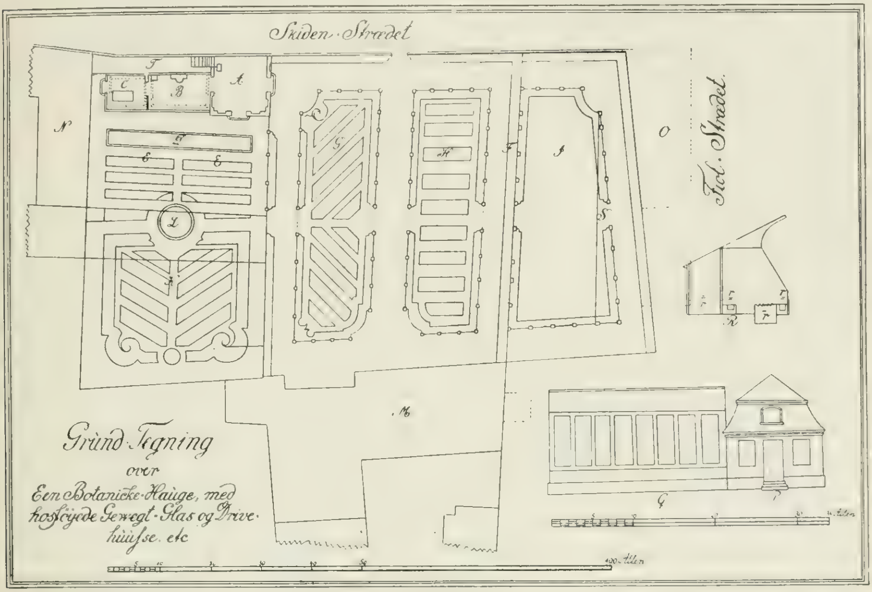


Fig. 124.

en Urte Gaards-Mand for *in Horto Botanico,* samt at kiøbe fremmet frøe og Planter.“ Det synes, som om Haven delvis har været anvendt til Lysthave for den derboende Professor. I al Fald klager Johannes de Buchwald i 1723 over, at „vores hortus botanicus haver til dato haft for lidet rom“, og foreslaar, at Haven bliver „med et Planckeværck afdeelt, saa at den Hr. Consistorialis, som opterede samme Residence, maatte have dend deel af haven, som er neest bag huuset, og dend anden part, som ligger mod skidenstrædet, horte til horti botanici brug.“ Joh. de Buchwald udgav i 1720 en paa Latin skrevet Bog: „Specimen Medico-Practico-Botanicum“ med Beskrivelse af en Del Urters Anvendelse oversat paa Tysk af hans Søn Balthasar Johannes de Buchwald, 1721, af hvilket Værk det fremgaar, at Planterne i den botaniske Have er bleven omplantede i Aaret 1719 og anbragte i alfabetisk Orden.

Efter Ildebranden i København 1728 blev Haven noget formindsket i Areal paa Grund af de omliggende Gaders Regulering. Haven trængte saaledes allerede den Gang til at blive flyttet til en rummeligere Plads, men der skulde dog hengaa over 40 Aar inden nogen Forandring i denne Henseende skete. I dette Tidsrum hører man ikke meget til Haven, og med de Midler, der stod til Havens Disposition, lod sig heller ikke meget udrette; 1655 hører vi dog, at Haven havde en Gartner, som fik 30 Rdl. i aarlig Løn. I 1769 begyndte det at dages for Haven. Christian VII skænkede nemlig ved Reskript af 3. Februar 1769 2500 Daler til Universitetet, „hvoraf Renten skulde anvendes til Havens „Istandsættelse og bestandige Dyrkelse." Og nu var der endda Udsigt til Udvidelse paa Stedet, idet Kongen 1770 lovede at ville øge den botaniske Have med Communitetets Have og ved indtrædende Vakancer tillige med de Haver, som Sognepræsten og 1ste Kapellanen ved Frue Kirke sad inde med.

Det er sandsynligt, at Christen Friis Rottbøll, som var Professor i Medicin ved Universitetet og som nylig ud mod Skidenstrædet havde faaet opført et Væksthus af 16 Fods Længde og 8 Fods Bredde, med Glæde har imødeset den i Udsigt stillede Udvidelse, men iøvrigt har Universitetets Styrelse næppe billiget Planen, i al Fald kommer den ikke til Udførelse. Kongen fremkommer nu med et nyt betydeligt Tilbud, idet han s. A. skænker Universitetet en Del af Oeders botaniske Have ved Amalienborg (hvorom mere senere) med samt Bibliotheket, dertil 5000 Kr. til Istandsættelse og aarlig 300 Rbd. af Partikulærkassen til Vedligeholdelse. Rottbøll er imod Flytningen og udtaler sig saaledes om Universitetshaven: .... „jeg kan calculo Mathematico bevise, at der med al Magelighed kan staae over 2000 Spec., som er alt det den upsalske Have har," men Universitetet modtager dog Gaven og allerede samme Aar sker Overtagelsen. Universitetshaven blev dog i Brug endnu i 8 Aar, hvorefter den blev overdraget som en Lysthave til den Professorbolig, som den havde været knyttet til.

Af denne ældste botaniske Have i Danmark eksisterer to Planer. Den ene, som er gengivet her i Fig. 123, viser Haven, saaledes som den saa ud i 1757. Den anden Plan — Fig. 124 — maa formodes at være tegnet mod Slutningen af Havens Eksistens; det synes som den foreliggende Plan er Forslag til Udvidelse af Haven. Figuren her er reproduceret efter en Tegning, som findes i Raadhusarkivet, rimeligvis en Kopi af ret ny Dato efter en ældre Tegning i det store Kongelige Bibliothek.

KØBENHAVNS UNIVERSITETS ANDEN BOTANISKE HAVE
(OEDERS HAVE)

Det var en Have i Drift, som Professor Rottbøll kom til at overtage, og selv om han ikke havde haft videre Sind til at komme bort fra Universitetshaven, har han dog sikkert snart fundet sig til Rette paa det ny Sted. (Haven, der overtoges, var anlagt af G. C. Oeder paa Foranledning af Frederik V, men om denne Haves tidligere Historie, vil der senere under Afsnittet Kongelige botaniske Haver blive givet Meddelelse). I Oeders Tid havde der været Gartner ansat ved Haven, hvilket næsten var ganske nødvendigt, dels fordi Haven i sig selv var af ret betydeligt Omfang (over 11,000 □ Al.), dels fordi der fandtes flere Væksthuse. Til Gartner ved Haven i Universitetets Eje udnævntes i 1770 J. W. Kæsemacher, der var kommen hertil fra Amsterdam. Hans Løn var 200 Rd. + 60 Rd. til Husleje og Brændsel. Skønt kun den mindre Del af den Oederske Have (se S. 339) var bleven skænket til Universitetet, fik den botaniske Have dog Lov til delvis at benytte den større Del (Kommerciekollegiets Del) af Amalienborghaven, navnlig havde Haven god Nytte af en stor Bygning, som fandtes paa dette Areal. Om Vinteren opbevaredes heri en Del Planter, og den afgav Bolig for Gartneren. Da nu Kommerciekollegiet i 1777 fik Brug for sin Grund, maatte Botanisk Have fortrække herfra, men fik dog Brugsretten forlænget til Foraaret 1778. Professor Rottbøll lod derfor udarbejde Planer til en Bygning, som skulde være baade Drivhus, Gartnerbolig, Bibliothek og Auditorium og anmodede om at maatte faa dette Kompleks opført paa et Jordstykke mellem Frederiks Hospital og Haven. Dette kom dog ikke til Udførelse, thi Kongen besluttede at tilbagekøbe Haven af Universitetet for 6000 Rd. og skænke Grund til en ny botanisk Have ved Charlottenborg, og i Løbet af 1778 rømmedes Amalienborghaven, og Inventarium og Planter overflyttedes til Charlottenborghaven.

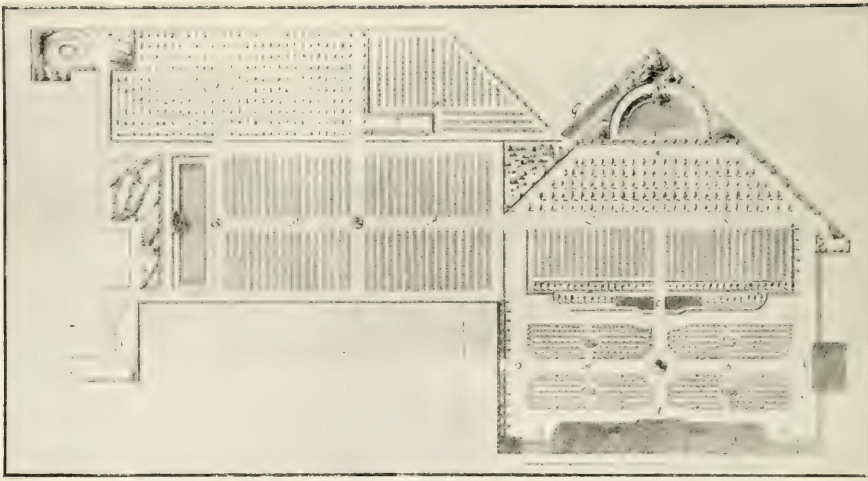


Fig. 125. Plan over Botanisk Have ved Charlottenborg. 1787.

KØBENHAVNS UNIVERSITETS TREDIE BOTANISKE HAVE
(CHARLOTTENBORG-HAVEN)

En Kommission, bestaaende af Professor Rottbøll, Gehejmeraad Holmskjold samt Konferensraad Aagaard nedsattes i 1777 for at gøre Forslag angaaende Indretningen af en botanisk Have i Slotshaven ved Charlottenborg, og Kongen approberede under 22. Juli 1778 de Planer, som Kommissionen havde fremlagt vedrørende denne ny Have. Under Arbejderne med Indretningen skulde Holmskjold have Tilsyn med Bygningernes Opførelse, C. F. Harsdorff skulde tilse, at de leverede Tegninger fulgtes, medens Rottbøll skulde svare til, at Haven blev anlagt og indrettet paa rette Maade. I Aaret 1787 blev en med talrige Bilag forsynet Beretning indgivet til Kongen af Holmskjold og Rottbøll. Det fremgaar heraf, at Havens Anlæggelse og Indretning havde kostet godt 21,425 Rdl., medens Aars-Budgettet paa dette Tidspunkt var 1363 Rdl. og nu blev forhøjet med 400 Rdl. (Se Fig. 125, der viser den Plan, som var vedlagt Beretningen).

Havens Styrelse var fra nu af lagt i Hænderne paa to Direktører, en valgt af Universitetet og en valgt af Kongen; de første Direktører var Rottbøll og Holmskjold. Senere gaves Direktionen videre Rammer; i 1798 bestod den af Statsminister C. F. Reventlow og Professorerne Wøldike, Vahl og Viborg.

Kæsemacher var død i 1780, og Niels S. Bache var bleven Gartner i hans Sted, medens Martin Vahl i 1779 var bleven Lektor. I Aarene omkring 1787 fandt nogle indre Stridigheder Sted, drejende sig navnlig om Lektorens Ret til at benytte Havens Materiale. Det

var en af Vahls Venner, Kammerraad Tønder Lund, og Havens Gartner — denne vel nærmest som Straamand for Professor Rottbøll — der i flere Piecer, som udsendtes til Offentligheden, havde Havens Anliggender under Debat. Vahl søgte sin Afsked, men fik senere Oprejsning ved at blive udnævnt til Professor. Men inden dette skete, var Bache bleven forflyttet til Frederiksborg som Slotsgartner, og i hans Sted var Holbøll bleven udnævnt til botanisk Gartner.

Frederik Ludvig Holbøll fødtes 14. Oktober 1765 paa Frydenlund, hvor hans Fader var Gartner og Slotsforvalter. Efter udstaaet Læretid var han Svend hos sin Fader, som han senere fulgte i Embedet. I 1793 blev Holbøll udnævnt til botanisk Gartner, men tiltraadte dog først Pladsen 1794, da han forud for Tiltrædelsen foretog en Studierejse til Holland og England. Holbøll kom til at virke under fire forskellige Professorer, nemlig Rottbøll (d. 1797), Erik Viborg, M. Vahl (d. 1804) og Jens Wilken Hornemann. Det lange Samarbejde og inderlige Venskab mellem de to Mænd, Holbøll og Hornemann, og deres store Dygtighed indenfor deres Fag, har uden Tvivl haft sin store Betydning for Havens Udvikling, saa at man kan sige, at de har sat deres Præg paa den botaniske Have for lange Tider.



Fig. 126. Frederik Ludvig Holbøll.

Det Areal, som Haven omfattede ved Anlæggelsen, var c. 3. Tdr. Land, et Areal, som snart viste sig at være for lille, men til en Udvidelse paa Stedet var der den Gang ingen Udsigt. Et Tilbud, som Gehejmeraad Classen i 1803 havde gjort Universitetet om at overlade dette 8 Tdr. Land Jord paa Østerbro, blev ikke modtaget, formentlig paa Grund af de forholdsvis store Udgifter, Nybygningerne vilde kræve. Man maatte saa se at skaffe Plads indenfor Havens egne Grænser og ved (1805) at rydde en Del overflødige Træer og Buske samt nogle Buxbomhække og ved at indskrænke Gangarealet lykkedes det for en Tid at skaffe nogenlunde Plads. I 1803 havde Kongen skænket 3000 Rdl. til Opførelsen af et Væksthus, det havde en Længde af $71^1/_2$ Fod, en Bredde af 14 Fod og en Højde af $10^1/_2$ Fod. Atter i 1811 betænkte han Haven med en stor Gave, idet han til Erstatning for et mindre Areal, som skulde afgives til Møntbygningen, skænkede en op til Haven stødende Grund,

hvorved Haven fik en Udvidelse paa 2000 Kv. Alen, endvidere skænkede Kongen 5000 Rdl. til dette Areals Indhegning og Bearbejdelse. Herfor skulde bl. a. indrettes en ny Dam for Ferskvandsplanter, en Kanal med rindende Vand for saadanne Planter, der vokser ved Aalob, endvidere en Plantning af Pile og et Anlæg for Alpeplanter.

I 1817 skete den Forandring i Havens Forfatning, at den gik helt over til Universitetet, baade pekuniært og administrativt, og efter den Tid har Enkeltmand staaet i Spidsen for Haven som Direktør. Hornemann, som havde siddet i Direktionen, blev som Professor i Botanik ved Universitetet Havens første Ene-Direktør.

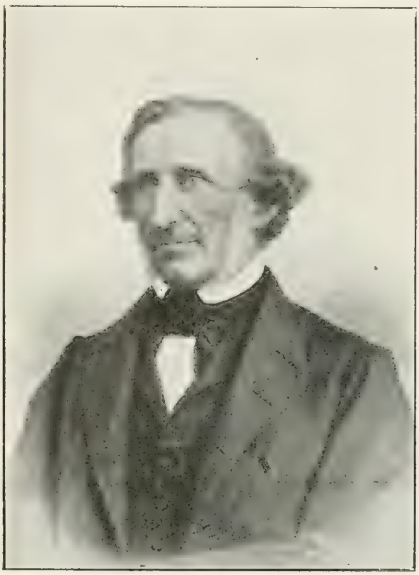


Fig. 127. August Weilbach.

Nu fremstod c. 1823 atter Forslag om at flytte Haven, hvilke gik ud paa at forene den botaniske Have med Rosenborg Have, men disse Planer gled dog ud i Sandet, og Haven maatte nøjes med sit indskrænkede Areal indtil 1844. Holbøll var død i Aaret 1829 og blev fulgt af Otto Josias Nicolaj Morch (f. $^{17}/_{7}$ 1799 i Aalborg, d. $^{25}/_{7}$ 1842 i København), medens Joachim Frederik Schouw efter Hornemanns Død i 1841 blev Havens Direktør.

Fra 1833 havde den Bestemmelse staaet ved Magt, at der til Arbejdskraften ved Botanisk Have foruden de 300 Rdl., hvormed første Svend lønnedes, maanedlig udbetaltes 125 Rdl. til den botaniske Gartner, som derfor var pligtig at holde Haven i forsvarlig Stand. Gartneren havde ogsaa drevet en Del Handel med Planter og Frø fra Haven, hvortil der i hans Instruks var hjemlet ham Ret indenfor visse Grænser. Der blev nu ved Professor Schouws Initiativ indført den Regel, at al Handel af Planter, Frø o. l. fra Haven blev forbudt, ligesom den omtalte Maade at lønne Arbejdskraften paa blev afskaffet. I Stedet ansattes endnu to Svende, medens Resten af Bevillingen blev anvendt til Lønning af fast og løs Arbejdskraft.

Budgettet, som i 1843 var 6312 Rdl. om Aaret, heri indbefattet Gartnerens og Assistentens Løn samt Bygningsudgifter, forhøjedes 1844 til 7200 Rdl og 1855—56 til 8200 Rdl.

Husene undergik i denne Periode en Del Forbedringer. Et gammelt kapsk Hus maatte i 1837 nedrives; i dets Sted opførtes Aaret efter for 3090 Rdl. et nyt Hus, bestaaende af 3 Afdelinger, hvoraf den midterste

skulde opvarmes ved varmt Vand, de to andre derimod ved de sædvanlige Røgkanaler. I 1843 blev er bevilget 9000 Rdl. til Opførelse af et Palmehus, 26 Alen langt, 12 Alen højt, 11½ Alen bredt, og et Orchidéhus paa 12 Vinduer i to Afdelinger, 26 Alen langt, 5½ Alen bredt og 4½ Alen højt. Og endelig blev i 1846 et ældre Hus delvis ombygget. Mørch var død i 1842, og i hans Sted udnævntes fra 5. Oktober s. A. August Weilbach (f. 23/11 1813 i København, d. sammesteds 11/5 1868) til Botanisk Gartner. Weilbach, der havde faaet sin Uddannelse i Fredensborg Slotshave og i Botanisk Have, tog 1835 Kunstgartnereksamen, var en Tid Medhjælper i Botanisk Have og rejste derpaa i Udlandet, hvorfra han blev kaldt hjem ved Mørchs Død. Han var en meget nidkær og duelig Embedsmand, som med Iver tog sig af Haven og interesserede sig meget for dens Historie og dens Udvikling. I 1844 fik Haven en Udvidelse paa 6 Skæpper Land, idet en Have, som havde hørt under Søetaten, blev overladt til Universitetet. Der forlangtes først en ret stor Sum i Afstaaelse, hvilket foranledigede Havens Direktør til at udtale, at man, hvis dette Krav opretholdtes, hellere maatte søge Haven flyttet eller subsidiært anlægge en Filialhave udenfor Byen. Kongen resolverede derefter, at Jordstykket skulde afstaas, mod at der opførtes et Plankeværk som Grænse og foretoges nogle Reparationer paa Bolværket mod Mastegraven samt udbetaltes Holmens Overekvipagemester en aarlig Sum af 200 Rbd. som Afsavn for Haven.

Professor Schouw trak sig 1852 tilbage fra sin Stilling som Direktør, og Professor Liebmann blev hans Efterfølger. Efter hans Død i 1856 antoges daværende Bibliothekar Joh. Lange til Direktør for Haven.

Professor Schouw havde i 1847 udgivet en „Foreløbig Fortegnelse over Havens Planter, hvilket Værk var ledsaget af en Plan over hele Anlæget. Da Haven efter den Tid, indtil den i Begyndelsen af 70erne skulde flytte bort fra Gammelholm, ikke gennemgik væsentlige Forandringer, giver dette Kort (se Fig. 128) god Oplysning om Havens Udseende i dette Tidsrum. Den laa lunt inde mellem Bygninger, værnet mod skarpe Vinde fra Nord og Nordøst, hvilket sikkert har været til Gavn for mange Planters heldige Trivsel, men paa den anden Side har andre Planter, som netop lykkes bedst under mere aabne Forhold, kun kunnet mistrives dèr. Husene laa dels direkte i Forbindelse med Beboelseshusene, dels frit, nogle af dem laa med Façaden mod Syd, andre vendte mod Sydvest. De urteagtige Planter var samlede i regelrette Kvarterer, enaarige, toaarige og fleraarige hver for sig, ligeledes var Lægeplanter og indenlandske Planter plantede i regelmæssige Kvarterer. Den øvrige Del af Haven var udlagt i Plæner og Busketter, den største Del af Arboretet laa i Havens sydlige Del. Alpeplanter dyrkedes paa Stenhøje paa tre forskellige Steder i Haven og Vandplanter i et regelmæssigt Bassin, hvilket dog led af den

Kort over den botaniske Have i Kjöbenhavn 1847.

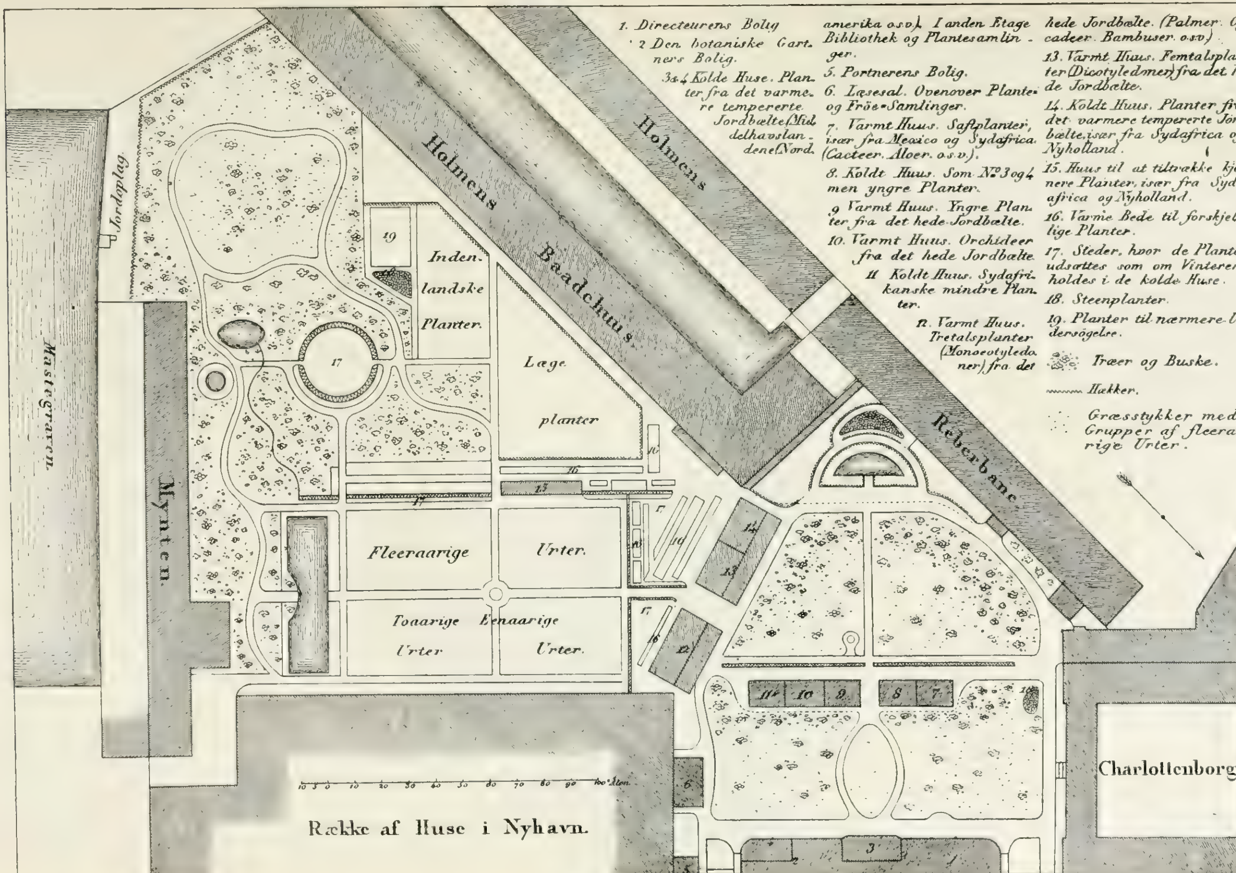


Fig. 128.

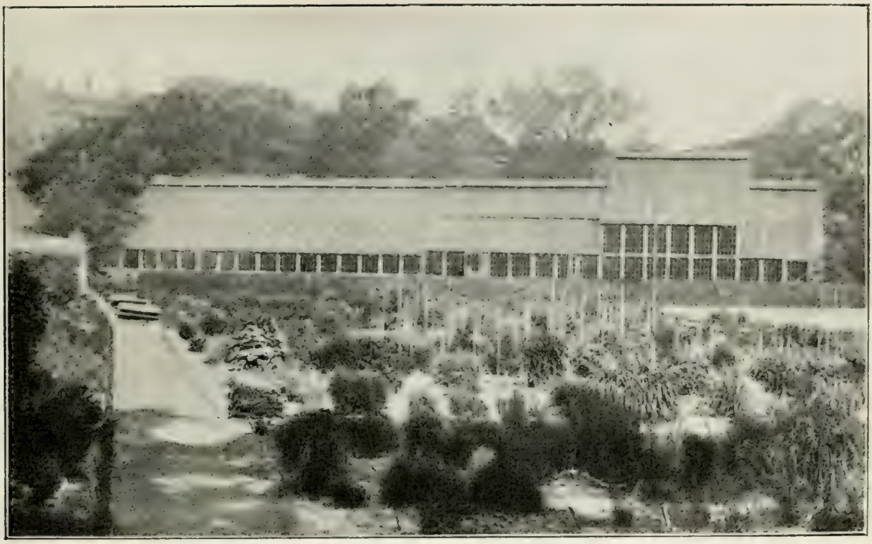


Fig. 129. Fra den botaniske Have ved Charlottenborg.

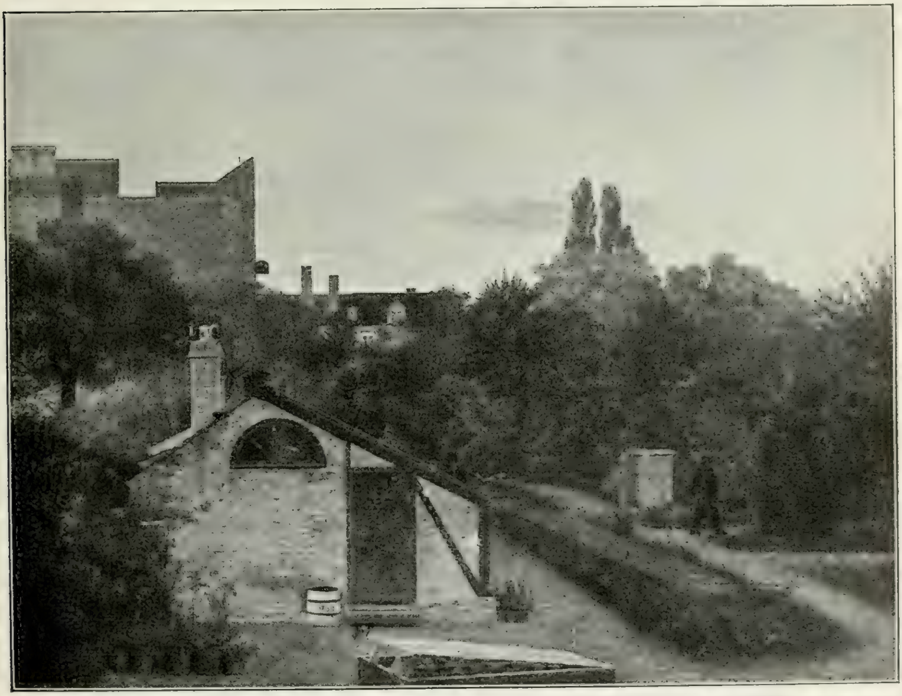


Fig. 130. Parti fra Botanisk Have ved Charlottenborg c. 1830.

Ulempe, at dets Vand var for varmt, da Spildevand fra Møntens Dampmaskine ledtes ud deri.

Forholdene var i det hele meget smaa og indsnævrede, og Havens Embedsmænd saa stadig med Længsel hen til en mulig Flytning (Se Fig. 129 og 130). Weilbach var i denne Retning ikke den mindst ivrige, og han fremkom i 1856 i Dagbladet „Fædrelandet“ med en Serie Artikler (under Mærket 1—24), i hvilke han behandlede flere af Havens Forhold. Han gør her opmærksom paa den skadelige Indvirkning, som Røgen, der med visse Vinde føres ind over Haven, udøver paa Planterne; han klager over den slette Jordbund, som for en stor Del bestaar af Murbrokker, medens andre Dele af Haven er altfor muldede paa Grund af den tidligere intensive Dyrkning med Køkkenurter, og han beretter, at visse Dele af Haven ved Højvande oversvømmes med Saltvand. Dertil kommer, at Grundvandet staar saa højt, at det allerede træffes i en Alens Dybde, og om Vinteren løber Fyrgravene derfor fulde af Vand. Forholdene var saaledes ikke saa idylliske, som man maaske ved et kortere Besøg i Aarets skønne Dage vilde faa Indtryk af. Weilbachs Artikler i Forbindelse med de Planer, som var fremme om Bebyggelse af Gammelholm, gav en frodig Jordbund for Tanken om Flytning; om disse Planers videre Udvikling berettes i Stykket om Haven paa Glaciet, den nuværende botaniske Have.

Efter at Planerne for den ny Have var bragt ud i Livet og ført til en lykkelig Afslutning — Weilbach skulde ikke opleve at se dette ske — blev Haven efterhaanden tømt for sin Bestand, medens Arealet blev overladt til Kunstakademiet og til Bebyggelse, og i April 1877 afleveredes det sidste Stykke.

I en lille Stump Have tæt op til Charlottenborg Udstillingsbygningen staar endnu enkelte Træer: *Celtis australis, Fraxinus angustifolia* og *Pyrus prunifolia* tilbage som Minde om Universitetets tredie botaniske Have.

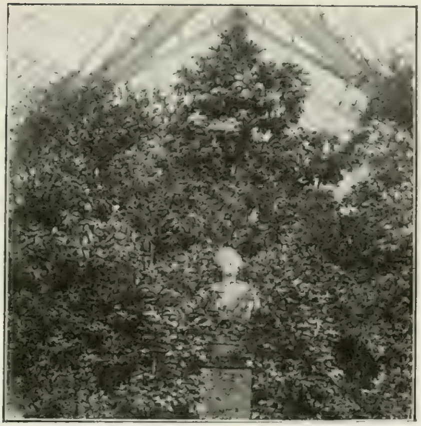


Fig. 131. Fra Botan. Haves Drivhuse. Koldhus Nr. 1 med Fr. V's Buste.

KØBENHAVNS UNIVERSITETS FJERDE BOTANISKE HAVE
(DEN NUVÆRENDE HAVE)

De to Forsøg, der havde været gjorte paa at faa Botanisk Have flyttet (1803 og c. 1820, se f. o.) havde ikke ført til noget Resultat; men nu var Tanken atter med Kraft bleven offentlig fremført af Weilbach. Spørgsmaalet havde ogsaa været omtalt i Rigsdagen, og Ministeriet henvendte sig derefter til Universitetet for at erfare dettes Stilling til en mulig Flytning.

Foranlediget herved nedsatte Konsistorium d. 4. November 1857 en Komité, bestaaende af Havens Direktør Joh. Lange, Professor Jap. Steenstrup og Professor J. G. Forchhammer, for at foretage forskellige Forundersøgelser angaaende en eventuel Flytning. Denne Komité afgav i Juni 1859 en Erklæring, gaaende ud paa, at den maatte anse Flytningen for nyttig, ja næsten nødvendig. At anvende en Del af Rosenborg Slotshave til en ny botanisk Have, hvilket Ministeriet havde peget paa, maatte Komiteen, selv om denne Haves Beliggenhed var bekvem, fraraade, dels fordi Jordbunden her efter Udsagn af en Komité af Gartnere, som i sin Tid havde undersøgt den, fandtes uskikket til finere Planters Dyrkning, dels fordi man fandt det uheldigt at berøve Byens Beboere en saa yndet Spaseregang, hvilket man nødvendigen maatte gøre, hvis man lagde en botanisk Have der, da denne i al Fald til visse Tider maatte være afspærret for Publikum.

Komiteen havde haft sin Opmærksomhed henvendt paa Grunde paa Frederiksberg, men den fandt det uheldigt at lægge Haven saa langt fjernet fra Universitetet; den burde lægges i en saadan Afstand, at

der ikke spildtes for megen Tid for Universitetslærerne og de Studerende, der skulde benytte Haven. Efter forskellige Overvejelser var Komiteen bleven staaende ved den Plan, at foreslaa Haven lagt paa Glaciet umiddelbart udenfor de Fæstningsværker, der var bleven indrømmede til Observatoriet. Komiteen ønskede at erhverve c. 12 Tdr. Land til dette ny Anlæg, og den havde tænkt sig, at Skraaningerne af den Del af Volden, som laa mellem Sølvgade og Gothersgade, skulde anvendes til Beplantning med Træer af den Art, som man plejede at optage i en botanisk Haves Arboret, men med særligt Hensyn til Skønheden og Publikums aldeles fri Benyttelse som Spaseregang. Dette Arboret burde da forenes med den øvrige botaniske Have paa Glaciet ved Hjælp af en Fodbro over Stadsgraven, og denne egentlige botaniske Have burde til visse Tider være aaben for Publikums frie Besøg.

For at forberede den botaniske Haves Flytning fandt Komiteen det hensigtsmæssigt, at der anlagdes en Planteskole for at man kunde tiltrække en Del Træer og Buske til Anvendelse i den ny Have, og i Overensstemmelse hermed lejedes af de militære Myndigheder et Areal paa c. 1 Td. Land tæt udenfor Nørreport (omtrent paa Grønttorvets Plads).

Man havde imidlertid endnu ikke faaet Vished for, at den ny botaniske Have vilde komme til at ligge paa det af Komiteen i 1859 foreslaaede Sted, thi Militærautoriteterne raadede endnu over hele Fæstningsterrænet, og det var endnu ikke afgjort, i hvilken Udstrækning Københavns Befæstning skulde nedlægges, og hvorledes det mulig frigivne Areal vilde blive benyttet. Forhandlinger med en Kommission, som det var overdraget at udarbejde Bebyggelsesplaner for Terrænet ned til Søerne, førte dog til, at denne Kommission paa sin i 1865 udgivne „Plan til Bebyggelse af Terrainet mellem Kjøbenhavns Demarcationslinie og den indre By, efter Fæstningsvoldenes Sløjfning“ havde indtegnet en botanisk Have paa den af Have-Komiteen angivne Plads, og i Loven om Demarcationslinien af 6te Juli 1867 § 4 bestemtes det, at et Areal af indtil 21 Tdr. Lands Størrelse kunde afstaas til Anlæg af en botanisk Have og et astronomisk Observatorium.

Imidlertid var Botanisk Gartner Aug. Weilbach bleven optaget i Komiteen, og i 1866 forøgedes denne yderligere med Professor bot. A. S. Ørsted, Professor Gram og Kvæstor Frydensberg med Bygningsinspektør Hansen som Medhjælp.

Der paafulgte nu en lang Række Forhandlinger mellem Komiteen og Konsistorium, Kultusministeriet, Krigsministeriet og Finansministeriet samt Københavns Kommune om en Række Spørgsmaal, drejende sig om Universitetets Ejendomsret til den gamle botaniske Haves Grund, Muligheden for et helt eller delvist Mageskifte mellem den gamle og den ny Haves Areal, den ny Haves Størrelse, Erhver-

velsen af nogle Kommunen tilhørende Arealer ved Farimagsvejen o. m. a., og som Følge af disse Forhandlinger trak Havesagen i Langdrag. Komiteen undergik i denne Tid nogle smaa Forandringer, idet Gartner Weilbach i 1868 døde og erstattedes med Th. Friedrichsen, medens Kvæstor Frydensberg erstattedes med Kvæstor Gedde, og i 1871 indtraadte Kaptajn, Brygger J. C. Jacobsen i Komiteen. Og nu var man kommet saa vidt frem i Arbejdet, at der

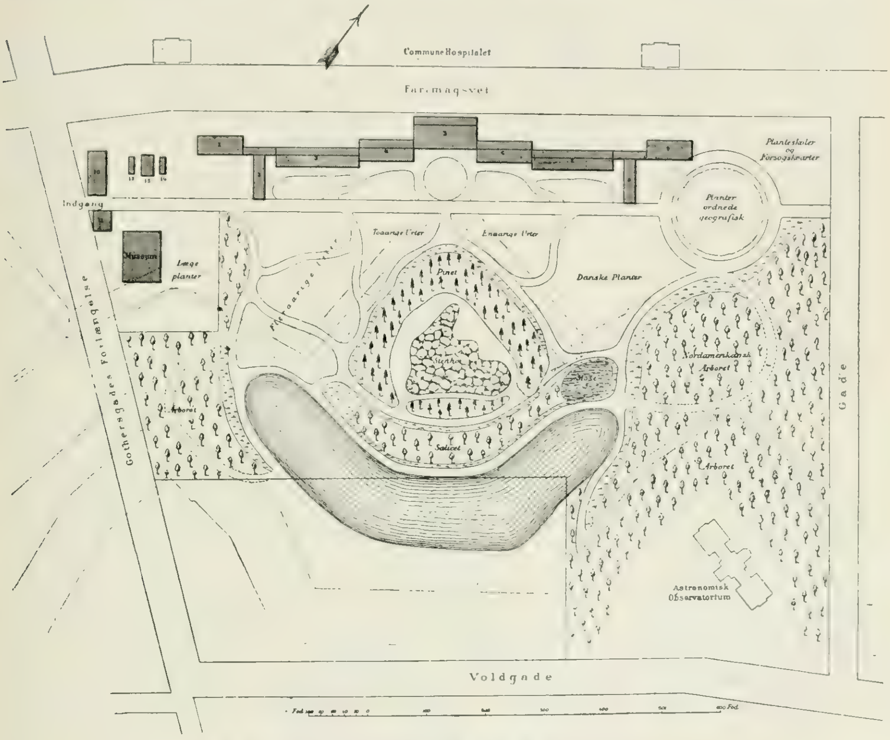


Fig. 132. Forslag til Botanisk Have. 1870.

paa Finansloven for 1871—72 kunde bevilges til Anlæg af en ny botanisk Have paa Glaciet et foreløbigt Beløb paa 25,000 Rdl.

Komiteen havde allerede i 1870 udarbejdet en „Beretning om Universitetets paatænkte nye Botaniske Have". Denne Beretning var ledsaget af to Planer, en for Musæet og en for selve Haven med de derpaa liggende Bygninger. Beretningen var særlig beregnet til Uddeling blandt Rigsdagens Medlemmer for at gøre disse nærmere bekendt med, hvilke Kaar Haven forhen havde arbejdet under, og hvorledes man i store Træk havde tænkt sig den ny Have.

Som det vil ses af Planen over Haven (Fig. 132) var det Tanken at lægge alle Væksthusene i en fortløbende Række langs Farimags-

vejen. Endvidere fremgik det af Beretningen, at det var Komiteens Tanke at omgive hele Haven med en Mur og at planere Arealet med Undtagelse af en midt i Haven beliggende Bastion, som skulde anvendes til Stentoj og til en Del af Arboretet. Ogsaa Dele af Voldskrænten, som skulde bruges til Arboret, skulde heller ikke planeres. Man agtede ogsaa til Dels at gennemføre en plantegeografisk Ordning og endelig vilde man ved Havens Anlæg stræbe at fyldestgøre Skønhedens Fordringer saavel i dens enkelte Dele som i de mange og forskelligartede Deles Forening til et harmonisk Hele.

Denne Beretning frembragte i Tidsskrift for Havevæsen en livlig Diskussion. Tidsskriftets Redaktor J. A. Dybdahl, Docent F. Didrichsen og Kammerjunker Rømer (som skrev under Pseudonymet: C. Rasmussen, Havemand) angreb Komiteens Planer, og Beretningen forsvaredes i særlige Piecer af daværende Cand. mag. Eug. Warming og Professor A. S. Ørsted.

Docent Dybdahls Artikel var meget saglig og indeholdt mange berettigede Anker mod Forslaget. Hans Indlæg gik i første Linie ud paa at foreslaa, at Haven ikke blev lagt paa Glaciet, men nærved Landbohøjskolens Have paa Pladsen mellem Sygehjemmet, Bülowsvej og Ladegaardsaaen (5 Td. Land), idet han mente, at man ved at vælge Pladsen her vilde kunne bygge Væksthuse og Musæum, men nøjes med smaa Frilandsanlæg og navnlig helt undvære Arboretet, da man i den nære Landbohøjskoles Have havde et saadant og tillige en smuk Stenhøj saavel som Samlinger af Lægeplanter og agronomiske Planter. Han kritiserede den foreslaaede Væksthusrække (til hvilke Weilbachs Tegninger og Modeller var lagt til Grund) og i ikke mindre Grad selve Have-Anlæget, og han sluttede med at udtale: „Hvis imidlertid det hele af Komiteen til botanisk Have nu udsete Terrain skulde blive indtaget dertil, foreslaae vi, at man sikkrer sig en landskabsgartnerisk smuk Benyttelse deraf ved at henvende sig til en eller anden i denne Retning anerkjendt dygtig Anlægsgartner."

I et Bilag til „Beretningen" læste man under det arktisk-alpine Rige: „Dette plantegeografiske Rige har en særlig Interesse derved, at de fleste af de danske Bilande, Grønland, Island og Færøerne, høre hertil, hvorfor det ogsaa i den nye Have vil blive gjengivet paa en tiltalende og anskuelig Maade. Dette kan nemlig uden Vanskelighed ske ved at give „Stenhøien", den med Sten besatte Høi, paa hvilken man netop pleier fortrinsvis at dyrke de arktisk-alpine Planter, en til dette Øiemed svarende Tillempning. Til denne Brug vil en omtrent midt paa den til Haven bestemte Del af Glaciet liggende Bastion fortrinlig egne sig. Den har en Høide af omtrent 25 Fod, og en Del af Skraaningen vil blive anvendt til at gjengive de Plantebælter, som ligge over Skovgrænsen paa Alperne. Paa de nederste 5 Fod plantes Dværgfyrren for at betegne Skovgrænsen, der ligger paa 5,500 Fod,

derpaa følger et Bælte (den alpine Region), af lave Buske, blandt hvilke Alperoserne og Ellen ... ere herskende, som naar op til 7000 Fod og indtager de næste 5 Fod af Høiens Skraaning. Mellem 7000 Fod og 8500 Fod ligger det øverste Plantebælte (den subnivale Region) beklædende omtrent 10 Fod af Høiens Skraaning. Det er her, at talrige Saxifrager, Ranunkler, Drabaer, Primulaer, Entianer, Silener o.m.fl. strække sig op til den Bjergets Top bedækkende evige Sne."

Dette gav „Havemand Rasmussen" Anledning til i sin Kritik at ytre: „Der mangler blot for at fuldstændiggjøre Legetøiet, at den evige Sne blev fremstillet med Meelkalk og Kridtstene, at der paa Steenhøien blev anbragt en Miniatur-Sennhytte og nogle forlorne Geder, og at der ved Foden af Høien imod Statsgraven blev opslaaet et Brædt med: her er Middelhavet og dets Flora, samt at lade dette blive repræsenteret af nogle Potter med Laurbær-, Orange-, Oliven- og Myrtetræer, indfattede af Lavendler og Salvier."

Heldigvis blev der intet Hensyn taget til Forslaget om at flytte Haven ud paa Frederiksberg, hvilket maaske nok vilde have været til Gavn for Landbohøjskolen, men sandsynligvis til liden Baade for Universitetet. Angrebene gjorde dog deres Gavn, thi de har maaske bevirket, at de to Kapaciteter H. Flindt og Tyge Rothe blev tagne med paa Raad.

Ved Behandlingen i Rigsdagen (Samlingen 1870—71) af Forslaget om at bevilge de føromtalte 25,000 Rd. til foreløbige Arbejder opstod en langvarig Diskussion om den botaniske Have; det blev fra et Mindretals Side foreslaaet at udstemme Bevillingen, for at man kunde faa Tid til at tage under Overvejelse, om Haven ikke kunde lægges et andet Sted, ligesom der udtaltes Ønsker om at faa mere detaillerede Planer. Minister Hall udtalte under Behandlingen i Tinget Muligheden af, at der vilde blive udskrevet en offentlig Konkurrence.

Ministeriet tilskrev kort derefter Komiteen og henstillede til den, at den tilkaldte landskabsgartnerisk kyndig Hjælp, og i Overensstemmelse hermed foreslog Komiteen, at Landskabsgartner H. Flindt og Slotsgartner Tyge Rothe blev tilkaldte som Raadgivere mod passende Honorar, hvilket Ministeriet tiltraadte.

Landskabsgartner, senere Haveinspektør, Flindt udarbejdede Planerne angaaende Havens Anlæg paa Grundlag af de Krav, som Komiteen maatte stille med Hensyn til den botaniske Ordning, og det lykkedes Flindt uden at forstyrre det hele Anlægs systematiske Ordning at forbinde den af Komiteens Flertal antydede Gruppering med den af Professor Ørsted med saa megen Varme anbefalede Plan til et nordamerikansk Arboret paa en særdeles tilfredsstillende Maade. Tyge Rothe havde i Forbindelse med Brygger Jacobsen Planlæggelsen af og Tilsynet med Opførelsen af Væksthusene under sig.

Havens Anlæggelse og Husenes Opførelse saavel som Bygningen

af Tjenesteboligerne stod paa i Aarene 1871—74. Bekostningen ved Havens Anlæg og Husenes samt Tjenesteboligernes Opførelse androg i alt c. 642,000 Kr., hertil nogle private Tilskud fra Brygger Jacobsen. Første Aar udførtes navnlig Entreprenørarbejderne med Afgravning og Planering af Volde og Opfyldning af Dele af Stadsgraven; disse Planeringsarbejder var meget betydelige, efter en foretagen Beregning flyttedes ialt 168,000 Kubikmeter Jord. Plantningen af Arboretet fandt i det væsentlige Sted i 1872—73.

Den 1. Juni 1874 kunde Komiteen aflevere Haven til dennes Di-

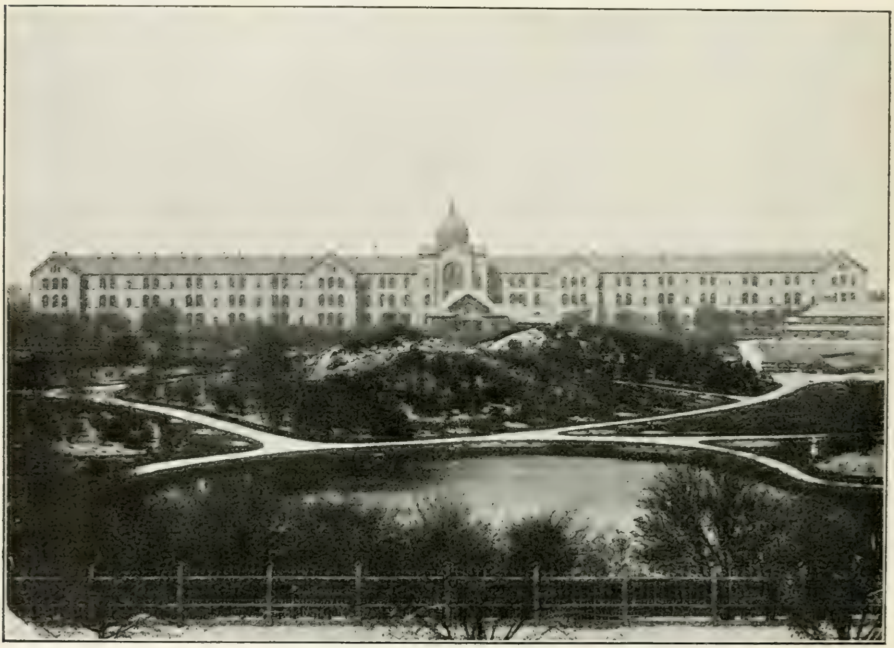


Fig. 133. Vue over Botanisk Have c. 1885.

rektion og dermed sluttede Komiteen sin Virksomhed. Samme Aar den 9. Oktober aabnedes Haven for Publikum.

I Regler for Adgang til Haven, som samtidig udstedtes, bestemtes det, at Haven skulde være aaben for Publikum daglig fra Kl. 1 til Solnedgang, at der til Personer, som ønskede Adgang udenfor disse Tider, kunde udstedes Adgangskort, lydende paa Navn, mod en Betaling af 8 Kroner (Familiekort 16 Kroner), medens Studerende kunde faa gratis Adgang til Kvarteret for Lægeplanter fra 8 Morgen til Solnedgang, at Palmehuset var aabent hver Dag fra 3—6 Em.*) og de lavere Huse aabne 3 Gange om Ugen samt at Barnevogne og Hunde ikke maatte medtages i Haven.

*) Senere er dette ændret til 2—6, senere igen til 1—5.

København havde faaet sig en ny botanisk Have og var derved bleven et værdifuldt Parkanlæg rigere. Den af Flindt udarbejdede Plan viste sig ogsaa i sin færdige Skikkelse at være et smukt Anlæg, som Aar for Aar blev skønnere og skønnere, saa at man med en vis Ret kan sige, at kun faa botaniske Haver i Verden i landskabelig Henseende staar over vor Have. (Fig. 133.)

Haven har Form som en uregelmæssig langstrakt Firkant, c. 380 m lang og 270 m bred, mod Øst skærer Observatoriets Grund sig som en Oval ind i Havens Areal. Haven, der ved sit Anlæg maalte $9\frac{3}{4}$ hekt. ($17\frac{3}{5}$ Td. Land), bestaar af et større Dalparti, hvori den



Fig. 134. Stenhøjen i Botanisk Have 1918.

9,000 □ m store Sø — den omdannede Stadsgrav — befinder sig. Vandspejlet er $1\frac{1}{4}$ m over Havets Overflade, Søens Dybde er omkring 3,20 m., frisk Vand kan tilføres ad en underjordisk Ledning fra Sortedamssøen. Fra Dalpartiet hæver Terrænet sig til den ene Side (Øst og Sydøst) temmelig stejlt opimod Boulevarden og Observatoriebakken, dennes højeste Punkt er 13 m; til de andre Sider stiger Terrænet mindre brat og breder sig snart ud i en stor jævn Flade, som indtager den største Del af Haven. Paa dette Plateau er Funktionærboligerne, Musæet og senere Botanisk Laboratorium byggede; Væksthusene ligger i Havens nordre Del, dels paa Plateauet, dels i Dalsænkningen.

Ved Beplantningen af Arboretet blev der fulgt en systematisk Plan, hvorefter hver enkelt Families Træer blev plantede i Grupper

for sig; men ikke alle Familier indenfor hver Orden blev lagt samlede, saaledes anbragtes Æblefamilien langt fjærnet fra Stenfrugtfamilien, de skaalbærende langt fra Pilefamilien; dette blev formentlig gjort for at fordele de Familier, som havde mere fremtrædende Blomster, over hele Haven. Ligeledes blev alle de perennerende urteagtige Planter familievis plantede i Grupper eller Rabatter over hele Haven. Den nærmere Ordning af Træer og Urtegrupper kan ses af Planen (Fig. 135). I Havens vestlige Hjørne blev anlagt en Samling af nordamerikanske Træer, plantede uden Hensyn til deres Plads i Systemet.

Til særlig Brug for de Studerende anlagdes langs Gothersgade i regelmæssige Bede et Studiekvarter — benævnet „Medicinsk Kvarter" — hvori overvejende plantedes Planter af økonomisk eller medicinsk Betydning. Omtrent midt i Haven hæver sig Stenhøjen (Se Fig. 134), anlagt paa en Dobbelthøj, omformet af en Bastion af det gamle Fæstningsværk. De højeste Punkter her er 13—14 m, og herfra har man et smukt Vue over hele Haven. Ved Søens nordre Ende er anlagt et Moseparti og hertil slutter sig Kvarteret for de indenlandske urteagtige Planter: „Dansk Kvarter."

Væksthusene dækker ialt en Grundflade af 2400 m^2, de har et Rumindhold af 12,000 m^3 og en dækkende Glasflade af 3100 m^2; højeste Punkt af Palmehuset er 19 m; de store Huse og visse Dele af de smaa har dobbelt Glaslag. Husene er af stor ornamental Virkning, som de ligger i Baggrunden af Haven, og omend de ligger ret højt, er de dog ved høje Bygninger i Farimagsgade værnede mod Vinde fra Nord og Nordvest. Ved Anlæggelsen af Haven plantedes bag Væksthusene langs Farimagsgade en Del Popler, hvormed Hensigten var dels at skabe yderligere Læ, dels at fremskaffe en smuk Baggrund for Anlæget set fra den søndre Del af Haven og samtidig skjule for Blikket de ovennævnte Beboelseshuse. Den øvre Væksthusrække bestaar af 5 Afdelinger, nemlig to Ende-Rotunder for Koldhusplanter, en stor Midter-Rotunde for tropiske Enkimbladede, „Palmehuset" og to Saddeltagshuse, som forbinder Ende-Rotunderne med Palmehuset. I Palmehuset bæres et højere Midterparti af 18 Støbejærnssøjler; ad en Vindeltrappe kommer man op paa et omløbende Galleri, hvorfra man fra oven kan betragte Planterne i Husets Midterparti. Hele dette Anlæg af store Huse har en Længde af 94 m; Bagsiden af Husene optages af Værktøjsskure, Folkestue og Arbejdsrum. Foran Væksthusrækken løber en bred cementeret Perron, begrænset af en Balustrade; midt foran Palmehuset fører herfra en bred Stentrappe ned i Haven. Denne Stentrappe deler den lavere Væksthusrække i to lige store Dele. Under Perronen findes Varmeanlæget, Kulkælder, Maskinrum og Oplagsrum. Foran den lave Væksthusrække, bestaaende af 7 Afdelinger, alle ensidige, ligger to fritliggende Saddeltagshuse. Midt imellem disse ligger et Springvandsbassin, der ligesom Vaserne paa Balustraden er skænkede af Brygger Jacobsen. Øst for Væksthuskomplekset ligger det 12-kantede Akvarium, $9^1/_2$ m i Diameter og 5 m

højt. Desuden findes bag Husene en Del Bænke og Bakker, et Forsøgshus og et Formeringshus.

Varmeanlæget til Husene er baseret paa Opvarmning ved Damp. Der findes 3 store Dampkedler; Dampen herfra gaar over i et fælles Hovedrør og fordeles derfra til alle Husene. Til Opvarmning af Husene medgaar aarlig mellem 300 og 400 Tons Kul.

Det var fra først af Tanken, at Musæet skulde bygges samtidig med at Væksthusene byggedes, men forskellige Forhold gjorde, at Bevillingen til Musæets Opførelse blev udsat. Endelig i Aaret 1875 opførtes denne Bygning, hertil var bevilget 112,000 Kroner, heri indbefattet Montering.

Johan Lange, der havde været konstitueret Direktør for Haven fra 1855, blev i 1875 efterfulgt af F. Didrichsen, der virkede som Professor og Direktør ved Haven til 1885, og siden den Tid har Direktørstillingen været knyttet til et Professorat i Botanik ved Universitetet. Didrichsen har næppe sat noget Præg paa Haven i snævrere Forstand, den var saa ny, at der ingen Grund var til at foretage Forandringer, og ny Opgaver for Haven fremsatte Didrichsen ikke.

Haven havde under Forarbejderne for Flytningen skiftet Gartner, i Weilbachs Sted var Th Friedrichsen (f. i København $^{24}/_{9}$ 1827, død paa Frederiksberg $^{16}/_{1}$ 1907) antaget. Han havde siddet i Have-Komiteen og han havde, efter at Anlæget var afleveret til Haven, foretaget de Plantninger, som stod tilbage at fuldføre og endelig havde han ledet den store Flytning af Planterne fra den gamle til den ny Have. Han kunde derfor siges og følte sig ogsaa at være ét med denne ny Have, og han holdt gennem hele sin lange Virksomhedsperiode med rørende Pietet og Trofasthed fast ved det af Komiteen for Havens Drift fastsatte og ændrede kun deri, naar han af Omstændighederne blev tvungen dertil.

Men Udviklingen førte ret naturligt med sig, at der i Tidernes Løb dog maatte foretages Omlægninger og Smaa-Ændringer ved Haven. Ny Tider giver ny Krav, Embedsmænds Skiften vil ofte sætte sine Spor, ny Naboer vil kaste lystne Øjne paa Havens Omraade, som passende Basis for Udvidelse, og Træernes Vækst vil ganske naturligt fremtvinge Ændringer her og der. En af de første vigtigste Ændringer i Haven var Opførelsen af „Planteanatomisk Laboratorium". Professor Eug. Warming (f. $^{3}/_{11}$ 1841 paa Manø) var fulgt efter Didrichsen i Embedet som Professor i Botanik og Direktør for Haven, han kom hertil fra Sverrig, hvor han havde virket i 3 Aar som Professor ved Stockholms Högskola; han kom ladet med Energi og Virkelyst til sin ny Stilling, og just i en Tid, da der var Kræfter i Gang for at faa et Botanisk Laboratorium. Allerede i 1880 havde deri interesserede Botanikere indgivet et Andragende til Kultusministeriet om Oprettelsen af et selvstændigt plantefysiologisk Laboratorium. Kultusministeren fremsatte derpaa Forslag om Opførelse af en saadan Bygning, men Sagen nød ikke Fremme i Rigsdagen. Endelig ved

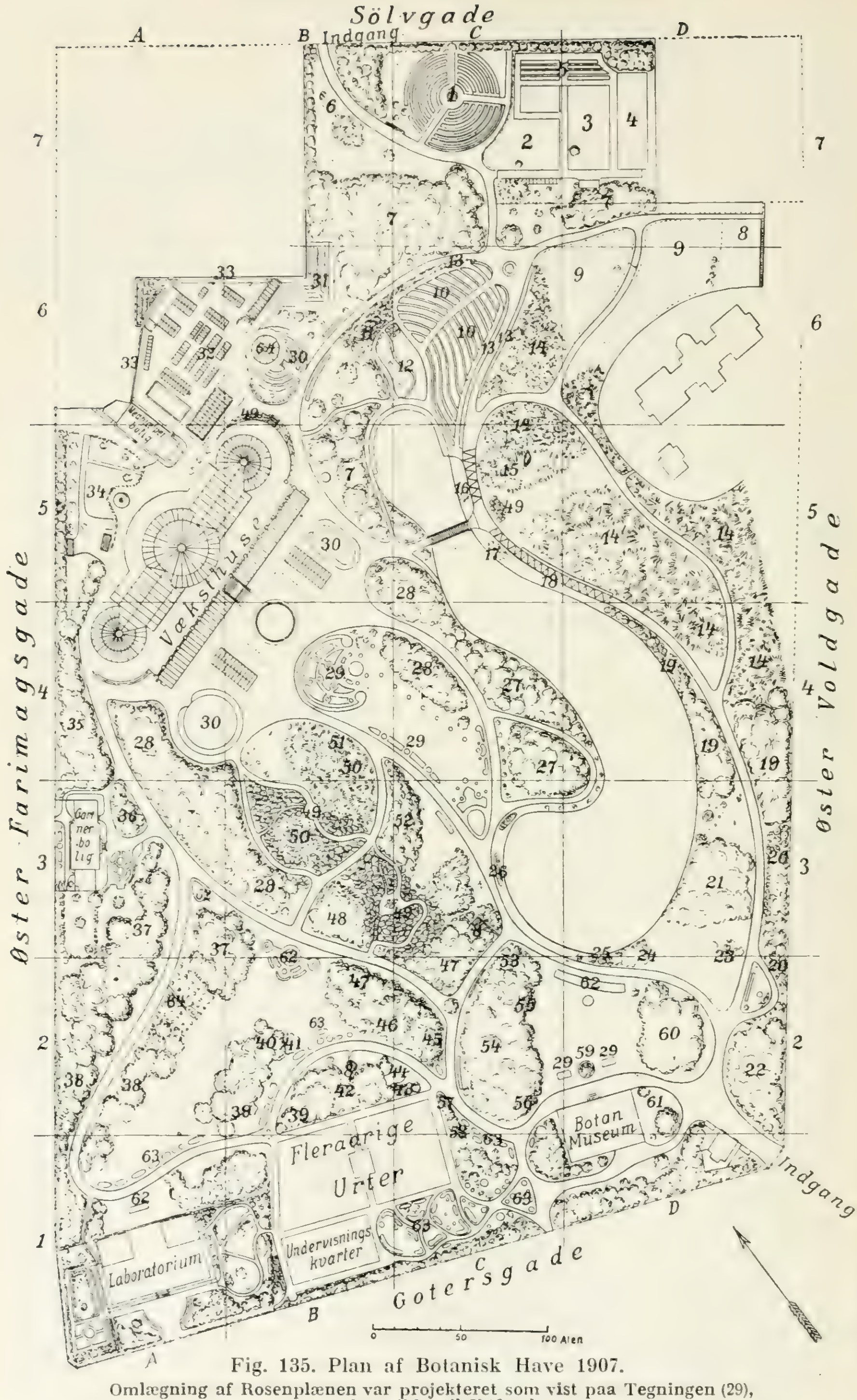


Fig. 135. Plan af Botanisk Have 1907.
Omlægning af Rosenplænen var projekteret som vist paa Tegningen (29), men kom ikke til Udførelse.

Forklaring til Tallene paa Plan af Botanisk Have 1905.

1. Enaarige Planter.
2. Planteskole.
3. Forsøgsareal.
4. Ubestemte Planter.
5. Stenbede.
6. Sølvbladfamilien.
7. Pilefamilien.
8. Magnetisk Observatorium.
9. Skolekvarter.
10. Danske Planter.
11. Dansk Stenhøj.
12. Mosebed.
13. Rubus (Brombær).
14. Granfamilien.
15. Taksfamilien.
16. Taxodium.
17. Ginkgo.
18. Slyngplanter (Løvgang).
19. Birkefamilien.
20. Gedebladfamilien.
21. Hasselfamilien.
22. Mandelfamilien.
23. Vedbendfamilien.
24. Hamamelidaceæ.
25. Kornelfamilien.
26. Hydrangea.
27. Ærteblomstrede.
28. Æblefamilien.
29. Rosarium.
30. Sommerbede for Koldhusplanter.
31. Sommerbede for Alpeplanter.
32. Varmebedsanlæg.
33. Espaliermure.
34. Jordmagasin.
35. Ælmefamilien.
36. Celtidaceæ.
37. Skaalfrugtfamilien.
38. Lønfamilien (ell. Ahornfamilien).
39. Valnødfamilien.
40. Magnoliefamilien.
41. Actinidia.
42. Platanfamilien.
43. Morbærfamilien.
44. Gøgeurtgruppe.
45. Bignoniaceæ.
46. Anacardiaceæ og Rutaceæ.
47. Olietræfamilien.
48. Ribsfamilien.
49. Stenhøje.
50. Cypresfamilien.
51. Alperosefamilien.
52. Rosenfamilien.
53. Berberisfamilien.
54. Lindefamilien.
55. Vrietornfamilien, Benvedfamilien, Staphyleaceæ.
56. Pibevedfamilien (Philadelphus).
57. Paulownia.
58. Ibenholtfamilien.
59. Kristtornfamilien.
60. Hestekastaniefamilien.
61. Buksbomfamilien.
62. Prydgrupper.
63. Biologiske Grupper.
64. Kjælnere Buske.

Lov af $^1/_4$ 1888 blev der, samtidig med at der blev sikret Midler til andre Instituter under Universitetet, bevilget c. 200,000 Kr. til Oprettelse af et Planteanatomisk Laboratorium. Laboratoriet opførtes i Aarene 1888—90 i Havens vestre Del paa den Plads, hvor det nordamerikanske Arboret laa, og Haven i snævrere Forstand mistede derved et ret betydeligt Areal (omkring $^1/_3$ hektare). Laboratoriet toges i Brug i 1890. Kort efter udkastede Professor Warming Plan til at faa omdannet en Del af „Medicinsk Kvarter" til et „Biologisk Kvarter". Omtrent Halvdelen af det medicinske Kvarter blev omdannet til det ny Formaal; endvidere anlagdes i samme Hensigt en Del Grupper i de tilgrænsende Plæner. I det følgende Ti-Aar foregik ikke større Ændringer indenfor Haven; men i Aaret 1902 fandt en Personændring Sted, idet Gartner Friedrichsen paa Grund af fremrykket Alder søgte sin Afsked. I hans Sted ansattes fra $^1/_{11}$ 1902 Axel Lange (f. paa Frederiksberg $^4/_{12}$ 1871) som Botanisk Gartner.

Polyteknisk Læreanstalt, som i Slutningen af 80erne var bleven bygget tæt op til Botanisk Have og var taget i Brug 1890, blev, som Aarene gik, snævrere og snævrere for dens stærkt voksende Virksomhed. Der fremkom derfor c. 1903 et Ønske om, at Haven vilde afstaa et Areal langs Farimagsgade, saaledes at Læreanstalten kunde faa den længe tiltrængte Udvidelse. Til Erstatning derfor skulde Haven paa et vist Aaremaal (50 Aar) have en Kommunen tilhørende Grund, som stødte op til Haven. Haven mente ikke — særlig af Hensyn til den Betydning, det polytekniske Studium har for hele Landet — at kunne modsætte sig den fremstillede Plan. I Overensstemmelse

hermed afstodes saa i 1904 og 1905 i alt c. $^{1}/_{3}$ hektare Jord, derved mistede Haven sin Forsøgshave og Dele af Mistbænkanlæget. En ny Forsøgshave anlagdes paa det af Kommunen lejede Areal.

Haven led i landskabelig Henseende ved Ændringen, idet den smukke Baggrund, den hidtil i Nordsiden havde haft i en Række Popler langs Farimagsgade, blev erstattet med en kold og kedelig Bygning. Haven forpligtede sig overfor Kommunen til som et Slags Vederlag for det paa meget billige Vilkaar lejede 0,7 hektare store

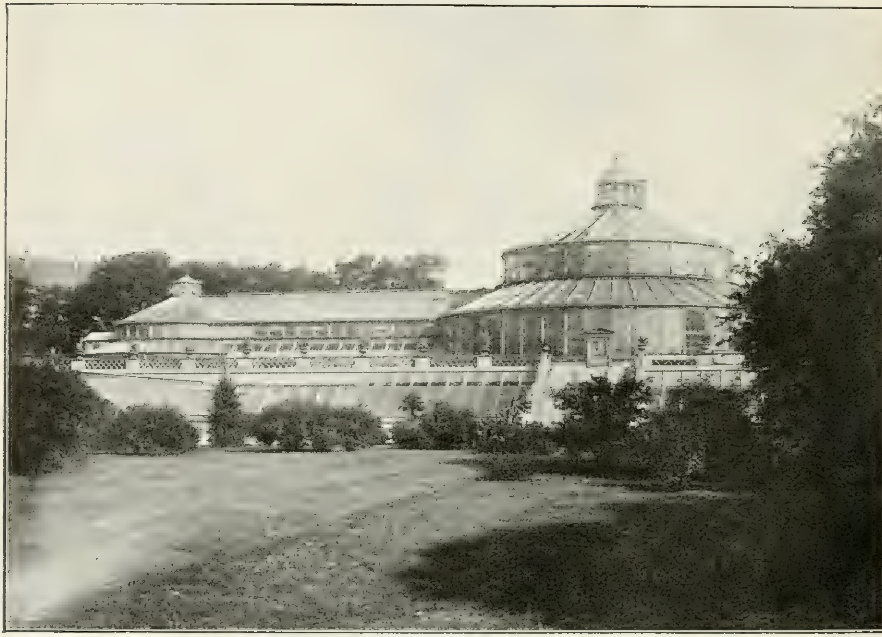


Fig. 136. Botanisk Haves Drivhuse 1906.

Areal at lade en Laage anbringe i Stakittet ud mod Sølvgade og at lade Færdsel gennem Haven ad Veje Øst for Søen finde Sted hele Dagen. Erhvervelsen af dette kommunale Anlæg — det saakaldte Sølvgadeanlæg — gav paa den anden Side Haven Lejlighed til indenfor sine Rammer at foretage nogle meget ønskelige Ændringer. Trægrupperne havde efterhaanden bredt sig saa stærkt, at de mange Steder overskyggede Staudegrupperne. Ny Voksekaar for de perennerende Planter var derfor særlig ønskelige; Pladsen, hvor de enaarige og toaarige Planter hidtil havde staaet, blev nu indtaget til Staudekvarter, de toaarige Planter fordeltes mellem Stauderne, medens de enaarige anbragtes i koncentriske Bede, anlagte i Plæner i det lejede Jordareal. Den 9. Oktober 1905 aabnedes Sølvgadelaagen for Publikum.

Efter at Professor Warming med Udgangen af 1911 havde søgt sin Afsked, blev Professor C. Raunkiær (f. $^{29}/_{3}$ 1860 paa Raunkiærgaard, Jylland) Direktør for Haven.

Af Ændringer indenfor Haven, foretagne i Tidernes Løb, kan foruden de ovenomtalte nævnes nogle ret betydelige Omlægninger af Stenhøjene, Anlæg af Stenhøj paa Foden af Observatoriebakken, og i 1918 Omlægning af Biologisk Kvarter i regelrette Bede, hvorved vandtes saa megen Plads, at „Medicinsk Kvarter“ eller som det nu kaldes „Undervisningskvarteret“ kunde faa noget af det i 1892 mistede Areal tilbage.

Havens nuværende Bestand af Embedsmænd og Funktionærer er som følger: Hele Institutionen staar under Havens Direktør, dog styres det plantefysiologiske Laboratorium uafhængigt heraf af Professoren i Plantefysiologi (Professor W. Johannsen, f. $^{3}/_{2}$ 1857 i København) med Hjælp af en Assistent. Ved det planteanatomiske Laboratorium er ansat en Assistent, og ved disse to Laboratorier findes en fælles Portner og Laboratoriebetjent. Musæet ledes af Musæumsinspektøren med Hjælp af en Amanuensis, en Konservatrice og en Musæumsbetjent; Bibliotheket styres af Bibliothekaren. Plantebestemmelsesarbejdet i Haven besørges af en Haveamanuensis. Haven ledes af den botaniske Gartner med Hjælp af (Jan. 1919) 2 Undergartnere, 3 Medhjælpere, 2 Fyrbødere, 4 Opsynsmænd, samt c. 20 mandlige og kvindelige Personer, som delvis er gartnerisk uddannede; det aarlige normerede Arbejdsdageantal er 7,000.

Til Bygningernes Vedligeholdelse er der beregnet 9,000 Kr., som er opført paa den samlede Sum til Universitetets Bygningers Vedligeholdelse. Hvert 5te eller 6te Aar maa der med særlig Bevilling finde en Hovedreparation af Husene Sted, ved hvilken Lejlighed al Jærnværk og Træværk bliver efterset; alle løse Vinduesrammer nedtages (Fig. 136 viser Palmehuset under Reparation 1906; Vinduesrammerne i venstre Side er nedtagne), efterses med Kitning og Maling.

Der er i de tidligere Afsnit talt om fire forskellige Haver, som har været knyttede til Universitetet, men mellem disse Haver gaar der mange Baand, som gør, at man med fuld Ret kan tale om Haverne som en enkelt Have, thi ved hver Flytning er Planter — baade Frilands- og Væksthusplanter — fra den gamle Have bleven overført til den ny, Havens Embedsmænd har stedse været med at lede Flytningen og Forbindelsen med Universitetet har stadig været til Stede, selv om den ikke al Tid har været saa fast og direkte som nu. Og medens der i det foregaaende hovedsagentlig er talt om de topografiske, administrative, økonomiske og personelle Forhold ved hver enkelt af de fire Haver, skal der i det følgende prøves givet en Fremstilling af, hvilken Betydning Haven har haft som Plantesam-

lings- og Undervisningsanstalt, hvorledes Plantetallet er tiltaget og Plantematerialet har vekslet gennem Tiderne, samt hvilke Opgaver Haven i det hele har søgt at løse.

I sine første Dage har Haven uden Tvivl næsten udelukkende været en Have for de medicinske Studerende, og den har vel tillige tjent til Glæde og Nytte for den Professor, som beboede „Residentzen“, der hørte til Haven. Der dyrkedes særlig Frilandsplanter og, i al Fald fra først af, mest danske Planter. Ole Worm skaffede flere udenlandske Planter til Haven, saaledes: *Rheum rhaponticum, Sco-*



Fig. 137. Paulownia imperialis i Botanisk Have.

rozonera hispanica, Solidago canadensis og *Mimosa pudica* m. fl. I den før omtalte Bog af J. Buchwald findes opført 200 Planter. Ved hvert Navn i Bogen er en tørret Plante, svarende dertil, indklæbet. Det er dog ikke givet, ja næppe sandsynligt, at dette var hele Plantebestanden i Haven, endmindre maa man antage, at alle deri nævnte Planter dyrkedes i Haven; det giver næppe noget rigtigt Billede af, hvad Haven indeholdt. Sit Herbarie-Materiale har Buchwald sikkert dels samlet i Haven, dels i Naturen, f. Eks. *Lathræa squamaria,* dels maaske hos Apothekerne, f. Eks. *Viscum album.* Af udenlandske Planter, som findes nævnt eller opklæbet i Bogen, skal som Eksempler nævnes: *Adiantum capillus veneris, Antirrhinum majus, Cannabis sativa, Cnicus benedictus, Cucumis sativus, Cyclamen europæum, Juniperus sabina, Lilium candidum, Physalis alkekengi* og *Veratrum*

album. Iøvrigt er Værket meget upaalideligt; i de forskellige Eksemplarer, der endnu forefindes, ser man tit ved samme Plantenavn forskellige Plantearter opklæbede.

Om Haven ved Amalienborg opgives, at Antallet af dyrkede Arter i 1761 var 650, medens det 1763 var naaet til 1500 Arter. Efter Flytningen til Charlottenborg kom der mere Vækst i Plantesamlingernes Artsantal. En skreven Katalog fra 1784, forfattet af Bache, udviser, at der dyrkedes 2855 Arter i Haven. 1801 er Tallet c. 5000, i 1813 opgiver Hornemann, som dette Aar udgiver en trykt Fortegnelse, Antallet til 7,500, i en Fortegnelse udgivet 1839 af Mørch findes c. 7,700, 1848 er det steget til 9,000 og 1857 til 9.500, medens der ved en kalkulatorisk Opgørelse i 1917 fandtes c. 12,000 Arter fordelte paa c. 2,570 Slægter.

Forholdet mellem Slægter og Arter er al Tid Genstand for Svingninger; Tendensen bør, som allerede af Schouw i 1847 hævdet, gaa i Retning af at søge at faa saa mange Slægter som muligt repræsenteret, og ved Reduktion af Plantebestanden med den Hensigt at skaffe Plads til ny Planter, vil man derfor som Regel særlig lade den gaa ud over artrige Slægter. Imidlertid har det sin Interesse af og til at samle talrige Arter indenfor enkelte Slægter, og ser man tilbage paa Plantefortegnelserne for de svundne Aar, vil man kunne gøre mange interessante Iagttagelser og danne sig Billeder af, hvad der har interesseret de styrende indenfor Haven, eller hvad der har været de vekslende Tiders Yndlingsplanter. 1803 andrager Holbøll Havens Direktion om Tilladelse til at købe 25 Arter *Erica* for 4 £ og samme Aar opgiver han Tallet af *Mesembrianthemum* til 40 Arter; i 1813 dyrkedes 42 Arter *Erica*. Det er de kapske Planter, som er dominerende! og endnu i Mørchs Tid ser vi, at disse Planter har Fortrinnet. I Mørchs Fortegnelse er opført: 75 *Mesembrianthemum*, 35 *Acacia*, 23 *Erica* og over 50 *Pelargonium*, deraf dog sikkert mange Havesorter. Til Sammenligning kan anføres, at der samtidig dyrkes af *Primula* 17, af *Saxifraga* 27, af *Agave* 4 og af *Begonia* 10 Arter. Tager man de fornævnte Slægter og undersøger, hvad der i 1918 fandtes i Haven, vil man for nogles Vedkommende finde en Nedgang, for andres en betydelig Opgang; Resultatet er: *Mesembrianthemum* 20, *Erica* 13, *Pelargonium* 25, *Primula* 64, *Saxifraga* 100, *Agave* 50, *Begonia* 65. Nævnes kan ogsaa, at Botanisk Have indtil 1834 kun besad 3 Arter tropiske Orchideer. Nævnte Aar fik den nogle Arter fra Hamburg og i 1839—41 en større Samling (60 Arter) fra Hofraad Hambroe, samt 77 Arter fra Mexiko ved Liebmann. Nu ejer Haven c. 180 Arter i Hus.

Sjældenheder og store smukke Eksemplarer af visse Arter har Haven stadig kunnet glæde sig ved at besidde og som nævnt før, har enkelte Individer fulgt med fra den ene Have til den anden. Af Planter paa Friland er et Eksemplar af *Paulownia imperialis* flyttet til



Fig. 138. Fra Palmehuset i Botanisk Have. Livistona chinensis.

den nuværende Have i 1871 (se Fig. 137); denne Plante eksisterer endnu. Af Væksthusplanter, som er Bindeled mellem den gamle og ny Have, kan nævnes den store Midterplante i Palmehuset *Phoenix spinosa,* som er kommet til Haven i 1807, og en ualmindelig kraftig *Livistona chinensis,* c. 75 Aar gammel (se Fig. 138), som, da den truede med at vokse igennem Glasset, nødvendigvis maatte falde for Øksen i 1919. Dens samlede Vægt var 615 kg og den bar, da den fældedes, 15 kg Frugter og 50 Blade. En Sukkerpalme, *Arenga saccharifera,* der ligeledes var overført fra Charlottenborghaven, blomstrede i Tiden Januar 1904—Eftersommeren 1906 (se Fig. 139) og døde efter afsluttet Blomstring, som det er denne Plantes Natur; den var dengang c. 75 Aar gammel.



Fig. 139. Fra Bot. Haves Palmehus. Sukkerpalme i Blomst.

Eksemplarer af *Agave americana* har blomstret gentagne Gange og et var i sin Tid endog offentlig udstillet. Dette var i 1836, i botanisk Gartner Mørchs Tid. Han fortæller i en lille Piece, skrevet i denne Anledning, at Eksemplaret stammede fra Skaane, hvor han selv havde været ovre at hente det. Blomsterstilken var allerede fuldkomment udviklet og Sidegrenene dannede. Efter at Planten med største Omhu var indpakket, førtes den med 8 Heste til Malmø, hvorfra den pr. Skib fragtedes til København, hvor den ankom 15. September, uden at en Gren var knækket eller Væksten hæmmet. —

En Sjældenhed paa Friland er det lille orientalske Træ af Æblefamilien *Eriolobus trilobata,* som staar paa Stenhøjen (se Fig. 140).

Haven har gennem Aarene forøget og vedligeholdt sin Plantebestand, dels ved Køb hos Handelsgartnere, dels ved Gaver af Planter eller Frø fra Botanikere, udsendt til fremmede Lande, og dels ved Bytte med beslægtede Institutioner i Udlandet. Havens begrænsede Budget har gærne lagt Hindringer i Vejen for at den første af de her nævnte Veje kunde benyttes i større Udstrækning, og ligeledes er der kun i ringe Grad kommet Planter til Haven ved at der her fra Landet er sendt Botanikere paa Rejser til fjærne Lande, i Sammenligning med, hvad store botaniske Haver i Europa har kunnet. Her maa dog nævnes, at Gartner Rathsack, som rejste i Mexiko med Botanikeren Liebmann, bragte Haven talrige Planter fra sin Rejse.

Den vigtigste Kilde til Rekruttering af Havens Plantebestand bliver

dog Udveksling af Frø og Planter med fremmede Haver. Det om Sommeren høstede Frø renses om Efteraaret og Vinteren, og i Januar udsendes en Katalog over, hvad Haven kan undvære. Denne Katalog udsendes til udenlandske botaniske Haver samt til en Række Skolehaver og Institutioner her i Landet. Efter de Ønskelister, som hjemkommer, udsendes Frøet i Marts Maaned.

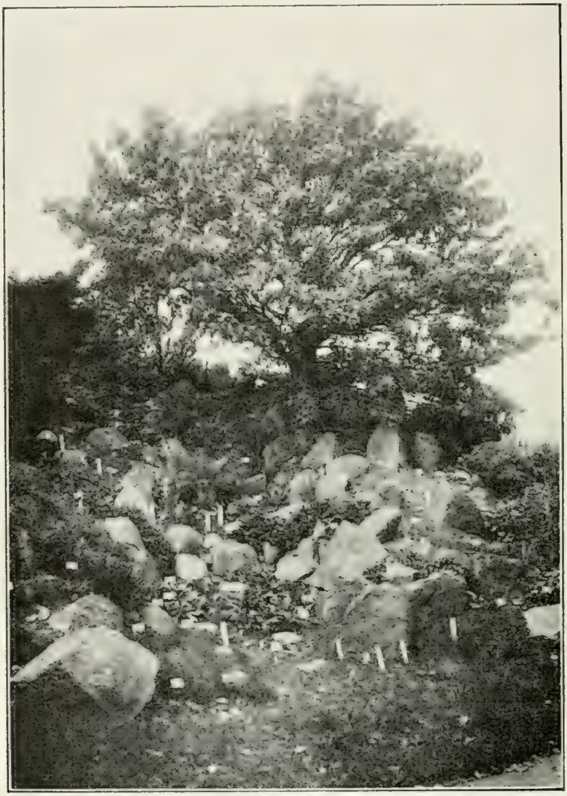


Fig. 140. Stenhøjen i Botanisk Have med Eriolobus trilobata.

Til Gengæld modtager Haven fra fremmede Haver Katalog over det dér høstede Frø, hvoraf vor Have udvælger, hvad den maatte have Brug for. Som Regel forlanges hvert Aar 2000 à 3000 Portioner. Haven selv udsender omkring 11,000 Portioner aarlig (Gennemsnit af de sidste 5 Aar). Af en Uddelingsliste, der gaar tilbage til 1841, aftrykkes her Antallet af uddelte Portioner for Aar med 20 Aars Mellemrum; 1841 uddeltes 2373 Portioner, 1861: 3084; 1881: 5733, 1901: 5557; 1918 var Tallet 12,250. Den stærke Forøgelse falder særlig paa de indenlandske Institutioner. Udvekslingen af levende Planter mellem fremmede botaniske Haver og vor Institution andrager aarlig nogle faa Hundrede Numre.

Det er sikkert en almindelig Opfattelse, at man altid kan stole paa de Navne, som findes ved Planterne i en botanisk Have. Desværre er det imidlertid ikke altid Tilfældet. Paa Grund af forskellige Fejlkilder, hvorpaa her ikke nærmere skal gaas ind, kan Planterne ikke være helt igennem korrekt etiketterede, og da dette er et Forhold, alle botaniske Haver er underkastet, er man stedse i Uvished, om de Planter, man modtager fra Udlandet, er rigtig bestemte.

Om Haverne er mere paalidelige nu end i gamle Dage, er vanske-

ligt at afgøre uden grundig Statistik, men saa langt tilbage som 1813 klages der over fremmede Havers Unøjagtighed. Vor Haves Embedsmænd har stadig søgt at holde Planterne rigtig bestemte, i tidligere Tider var det særlig Havens Direktør, som besørgede dette Arbejde. Professorerne Schouw, Liebmann og Lange har revideret talrige Planter, men med Havens stigende Udvikling blev det nødvendigt at ansætte en særlig Plantebestemmer — Haveamanuensis — hvis Opgave er stadig at revidere Havens Samlinger af levende Planter.

Der føres i Haven nøjagtig Bog over, hvorfra hver enkelt Plante er kommet, samt naar den er revideret o. s. v.; dette System, indført af Holbøll i 1795, er der med Flid vaaget over siden, og man er derved sat i Stand til at kunne give enhver Plantes Historie her i Haven.

Den botaniske Have holder stadig sin første oprindelige Bestemmelse at være en Studiehave højt i Ære. Derfor er den største Del af den om Formiddagen afspærret for Publikum, men tilgængelig for Studerende og Lærere med Elever, der udstedes uden Vederlag Studiekort og Lærerkort til alle dertil berettigede, som andrager derom.

I ældre Tider afgav Medicinerne det største Kontingent af dem, som studerede Botanik i Haven, men efter at denne Videnskab fra Aaret 1903 er ophørt med at være et tvungent Fag for nævnte Studiegren, er der kun enkelte Medicinere, som *con amore* søger Haven som Studiested, og dog benyttes Studiekvartererne sikkert i stigende Grad. Antallet af farmaceutiske Studerende er taget til, Statens Lærerkursus saavelsom Faglærerne o. m. a. benytter vor Have. Materiale til Professorernes Undervisning og Eksaminer skal ogsaa afgives fra Haven; desuden afskæres Materiale til Skolelærere og til Manuduktører o. s. v.; ialt afgives til Undervisning udenfor Universitetet og Farmaceutisk Læreanstalt omkring 1000 Portioner aarligt.

Foruden at være en Studieanstalt skal den botaniske Have tillige tjene til Oplysning og Glæde for Publikum og omend de fleste af de ca. 1,412,000 Personer, som aarlig passerer Laagerne, blot skyder Genvej gennem Haven, er der dog en stor Mængde, der nyder de Fordele, den yder som behagelig Spaserepark og Frilandsmusæum. Styrelsen har søgt paa forskellig Maade at gøre Haven tiltrækkende. Det ovenfor nævnte af Professor Warming udtænkte biologiske Kvarter skal ikke alene tjene som Undervisningsmiddel for de Studerende, men tillige hos de ikke faglærte vække Interessen for og aabne Øjnene for Planternes Ligheder og Forskelligheder. Planterne i dette Kvarter er ordnede efter saadanne Egenskaber og Karakterer, som har Betydning for Planternes Liv i Naturen eller som betinger deres Værdi som Kulturplanter. Saaledes er i en Gruppe sammenstillet Marehalm, Strandkaal og *Echeveria secunda*, alle med blaaduggede Blade, i en anden *Salvia argentea, Gnaphalium petiolatum*

og Lammeore, alle med tæthaarede Blade. Disse Gruppers Planter skal illustrere, hvorledes Naturen giver Planterne Værn mod stærkt udtørrende Klima. Kapske Vortemælk og amerikanske Kaktus stilles sammen for at vise Stængelsukulenter og for at illustrere, hvorledes systematisk vidt adskilte Planter kan have ens Vækstformer.

Husenes Tilgængelighed for Publikum skal ogsaa bidrage til at brede Interessen for Planternes Liv og de forskellige Floraomraader. Af og til arrangeres særlige Udstillinger af enkelte Plantegrupper. I



Fig. 141. Udstilling af Araceer og Commelinaceer i 1918.

1898 udstilledes saaledes, hvad Haven besad af Stenbræk *(Saxifraga);* i 1915 udstilledes en Samling af den tropiske Slægt *Begonia,* 1917 bød Haven paa en Samling Hængeplanter og endelig var i 1918 udstillet en Samling af *Araceer* og *Commelinaceer* med henholdsvis c. 125 og c. 25 Repræsentanter (Se Fig. 141).

Botanikere, der har været knyttet til Haven, ofte ogsaa Havens Gartnere, har dér, enten i Forsøgskvarteret eller i Husene, foretaget videnskabelige eller praktisk-økonomiske Forsøg. Disse Forsøg gaar langt tilbage i Tiden. Det ses saaledes af Have-Tidende 1841, at Botanisk Gartner Mørch samme Aar havde haft Forsøg med Silkeormes Fodring med Blade af forskellige Planter, beslægtede med Morbær, hvorved han kom til det Resultat, at den amerikanske Elm var en

god Foderplante for disse Dyr. Botanisk Gartner Weilbach planlagde Forsøg med Anvendelse af tykt Glas i Væksthuse og med Luftbevægelse i Væksthuse, som Middel til at yde Planterne naturligere Voksekaar; Problemet har en af vore driftige Handelsgartnere for en 8—9 Aar siden søgt at løse i sine egne Drivhuse. Botanikerne Samsøe Lund og Kiærskou har gjort Forsøg med Kaalsorter og beslægtede Planter, Docent Becker anstillede i 1894—99 Forsøg over Perleløgets Oprindelse og Magister O. Rostrup foretog i Tiden 1886—89 for Dansk Frøkontrol Forsøg med Frøs Spireevne. I de senere Aar har Professor W. Johannsen haft Forsøg med rene Linier i Bønner, medens Professor Raunkiær og Dr. Ostenfeld har syslet med Artsforholdene hos forskellige af vore Blomsterplanter og med Kimdannelse uden Befrugtning.

Selv om det er Haven i snævrere Forstand, som her omhandles, bør der dog tilføjes et Par Ord om det til Institutionen hørende Musæum og Bibliothek. Musæet, ledet af Dr. phil. O. Paulsen, omfatter dels Samlinger i Spiritus, dels Samlinger af Vedprøver og Frøsorter samt andre tørre Plantedele og som det mest omfattende: de paa Papir opklæbede tørrede Planter: Herbariet. Dette sidste er delt i 3 Hovedafdelinger, nemlig det arktiske Herbarium, som anses for det bedste i sin Slags, det danske Herbarium og Generalherbariet, hvilket rummer Planter, der ikke kan henføres til nogen af de to andre Afdelinger. Herbarierne omfatter ca. 475,000 Ark. Musæet er ikke offentlig tilgængeligt, men forevises paa Forlangende. Bibliotheket — ledet af Dr. phil. F. Børgesen — indeholdende særdeles mange værdifulde Bøger, er offentlig tilgængeligt 3 Gange om Ugen. Det rummer omkring 20,000 Bind.

Den botaniske Have har nu eksisteret i 319 Aar og den har i den Tid ført en ret omtumlet Tilværelse, idet den, som anført, har ligget paa fire forskellige Steder i Byen. Krav fra forskellig Side kan let føre med sig, at Haven atter en Gang helt eller delvis maa skifte Plads, men selv om Forholdene allerede nu i visse Henseender er indskrænkede, og selv om dens Beliggenhed midt i Byens Hjærte kan have uheldig Indflydelse paa mange Planters Trivsel, maa man dog ønske, at den saa længe som muligt maa kunne bevares uindskrænket paa sin nuværende Plads, saa at den kan opnaa det Præg af Ærværdighed, som klæder Haver saa smukt og som sikkert ikke mindst vil klæde denne i sig selv saa landskabeligt skønne Park.

SORØ ARBORET

I Slutningen af forrige Aarhundrede blev der mellem Bestyrelsen for Sorø Akademis Skove og Botanisk Haves Direktion og med Ministeriets Samtykke truffet Aftale om, at Botanisk Have i Sorø Skove

paa dertil egnede Pladser, som Skovvæsenet kunde afse, skulde indplante forskellige fremmede Træarter. Det var Tanken derigennem at forskønne Sorø Lystskov, men ikke at skabe noget botanisk systematisk Arboret. I Tiden fra 1903 er der nær Filosofgangen indplantet en Del Naaletræer, især Graner og Ædelgraner, samt en stor Samling Tjørn, medens der i Feldskov er plantet *Acer* i større Antal og talrige andre Træer i enkelte Eksemplarer, og endelig er der i Hundekildehave plantet en Samling Birke.

KIELER-UNIVERSITETETS BOTANISKE HAVE TIL 1864

VED Universitetet i Kiel, indviet 1665 af Hertug Christian Albrecht af Holsten-Gottorp, oprettedes i 1669 en botanisk Have, og Hertugen stillede en Del af Slotshaven til Disposition for dette Formaal. Det overdroges Johannes Daniel Major, Professor i theoretisk Medicin, at anlægge og bestyre Haven. Major havde haabet at faa hele den fyrstelige Have Nord for Slottet overladt til nævnte Brug, men den daværende Slotsgartner Heinrich Vack modarbejdede denne Plan og vilde have Major henvist til et lille kvadratisk Stykke Jord, Baumhof kaldet; men dette erklærede Major for uegnet til Formaalet, og Hertugen befalede derpaa, at der skulde afstaas en Fjerdedel af Slotshaven, samt at der til Hjælp i Haven skulde gives Fjerdedelen af den Arbejdskraft, som ydedes af de Bønder, der gjorde Pligtarbejde for Slotshaven.

Anlæggelsen af Haven stod paa i fire Aar og voldte Major megen Besvær — han taler et Sted om sit „blutsauren vierjahrigen untertänigst ehrlich gemeinten ersten Einrichtungsarbeit — bl. a. ved at Slotsgartneren ikke fuldtud vilde levere ham den lovede Arbejdskraft. Just som Major var færdig dermed, skete der nogle Forskydninger indenfor Lærerkræfterne ved Univesitetet, hvorved Major blev Professor i praktisk Medicin, medens Johannes Nikolaus Pechlin blev Professor i theoretisk Medicin og Botanik og som saadan overtog Ledelsen af Haven. Af Afleveringsdokumenterne fra Major til Pechlin ses det, at der paa nævnte Tidspunkt mest dyrkedes medicinske Urter; nogle ikke haardføre Planter forefandtes dog ogsaa.

Haven var (se Fig. 142) anlagt i regelmæssig Stil. Fra Gaden kom man ind ad Porten (c paa Planen), der foroven var forsynet med 3 marmorerede Kugler, under hvilke fandtes Hertugens forgyldte Navnetræk i en Laurbærkrans. Ved Indtrædelsen i Haven ad denne Port havde man et Vue over hele Haven. Ad en anden Port (ved e) kom man ad en Trappe ned til Ridebanen, som skilte Haven fra Slottet.

Blandt de Planter, som dyrkedes i eller havde været dyrket i Haven indtil 1673, kan nævnes: *Acorus aromaticus (Acorus calamus*), Blattaria fl. violaceo (Verbascum phoeniceum), Campanula*

*) Navnene i Paranthes er de nugældende Navne.

pyramidalis, Cerefolium hispanicum, (Myrrhis odorata), Flos africanus (Tagetes), Hyucca gloriosa (Yucca gloriosa), Laurus tinus (Vibunum tinus), Pomum amoris (Lycopersicum esculentum), Sophia chirurgorum (Sisymbrium sophia, Barberforstand). Ialt dyrkedes omkring 500 Arter og Havesorter.

Endvidere fandtes opført i Plantelisten *Aloe Gottorpiensis* [in effigie] d.v.s. et Billede af en *Agave Americana,* som i 1668 havde blomstret i den hertugelige Have ved Gottorp og hvorom Major havde skrevet et lille Værk i 4°.

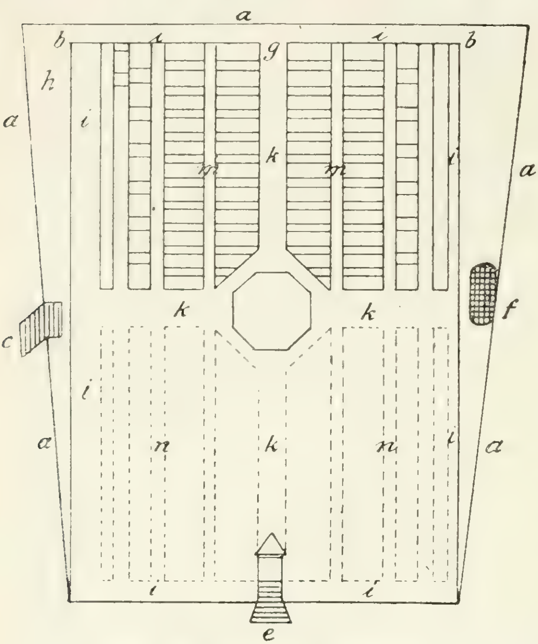


Fig. 142. Den ældste botaniske Have i Kiel.

J. N. Pechlin synes ikke at have vist nogen særlig Interesse for Haven; der foreligger intet om den fra de Aar, han beklædte Direktoratet. Det synes, som om Haven ikke har eksisteret ud over Aaret 1684.

I 1720erne blev der anlagt en ny botanisk Have: *Hortus medicus,* nærved Universitetsbygningen. Den var en Tid lejet ud og blev i 1727 overladt til Apotheker Christiani, som mod et aarligt Vederlag af 10 Rthl. overtog Forpligtelsen til at vedligeholde Anlæget som en medicinsk Have og levere Urter og Plantedele til Forelæsninger og Eksamener. Denne Akkord skulde overføres paa senere Indehavere af Raadsapotheket.

I 1802 fik Universitetet et medicinsk Hospital, hvilket Professor Georg Heinrich Weber oprettede, navnlig ved frivillige Bidrag. Ved dette Hospital blev det følgende Aar anlagt en ny botanisk Have og derefter ophørte det aarlige Tilskud paa 10 Rthl. til Apothekerhaven, som dog vedblev at høre til Apotheket indtil 1855, da Jordstykket gik over til Universitetet mod en Afstaaelsessum af 200 Rthl.

Den ny botaniske Have, hvis Anlæggelse stod under Professor G. H. Webers og Overlæge Fischers Opsigt, blev i 1804 overgivet til Webers Søn Friedrich Webers (f. 1781, d. 1823) Ledelse, som styrede den i omtrent 20 Aar.

Haven havde efter datidige Udsagn (1811) „rigelig Plads, forskel-

ligartet Terræn, gennemstrømmende Vand, godt indrettede Vaksthuse og en dygtig botanisk Gartner.“ Sidstnævnte Mand var Peter Høhle, som var i Havens Tjeneste fra 1806 til 1831. I Webers Tid udvidedes Haven to Gange, saaledes at den i 1822 maalte $4^{2}/_{3}$ Td. Land. Drivhusene bestod samme Aar af 7 Afdelinger, byggede dels ved Havens Anlæggelse, dels i 1816 og dels i 1820. Havens Plantebestand i 1822 var ret betydelig, nemlig omkring 6000 Arter. Der dyrkedes bl. a. 31 *Astragalus*, 11 *Begonia*, 55 *Campanula*, 108 *Mesembrianthemum*, 85 *Pelargonium*, 20 *Saxifraga;* af Bromeliaceer dyrkedes 4 Arter og af Orchideer i Hus 6 Arter.

Efter Fr. Webers Død var Ernst Ferdinand Nolte (f. $^{24}/_{12}$ 1791, d. $^{15}/_{2}$ 1875) Havens Direktør, og omkring 1855 var C. Dahle dens Gartner. Haven var i Sommertiden tilgængelig for Studerende alle Hverdage fra 7—12 og fra 1—7 og for Publikum var Haven aaben fra Juni til September to Gange om Ugen fra 4—7 Em.

ROSENBORGS
KONGELIGE BOTANISKE HAVE

I 1606 købte Christian IV en Del Grunde udenfor Voldene i den Hensigt at bygge sig et Lystslot og anlægge sig en Have for dér at kunne have et Sted at rekreere sig. Her byggede Kongen i Tiden 1610—1624 Slottet Rosenborg. I Haven var der til Tider ansat to Urtegaardsmænd (Gartnere) og flere Svende. Af en Instrux, udstedt 24. Marts 1633, fremgaar det, at der dette Aar skulde dyrkes et Bed fuldt af *Simplicia* (Lægeplanter). Dette kan maaske regnes for en Forløber for Rosenborgs botaniske Have, hvis Skæbne man iøvrigt ikke ved meget om; den synes næsten udelukkende at have været knyttet til Grundlæggeren Dr. med. Otto Sperlings Virksomhed dèr.

I Aaret 1638 havde Corfitz Ulfeld, som nærede en betydelig Interesse for Lægen og Botanikeren Otto Sperling, anbefalet denne til Kongen, „som en der var vel forfaren udi Urtevidenskaben, og hvem Hs. Majestæt skulde betro Inspektionen over sin Have.“ Christian IV fulgte Ulfelds Indstilling og udnævnte 7. Juni s. A. Otto Sperling til Læge ved Børnehuset i København og „derforuden have vi naadigst bestilt hannem at skal være vores *Botanicus* og have flittig Indseende med Haven ved vor Kiøbsted Kiøbenhavn, og tilholde Urtegaardsmanden, at han sig beflitter at have alle de Simplicia, som gror dog i vore Lande, hvorfore Vi hannem have aarligen tilsagt 200 Rd. in Sp. ....“ Det synes efter Ordlyden af Ovenstaaende at dømme, at Sperling har haft Overopsyn med hele Haven, men han har sikkert i særlig Grad taget sig af den botaniske Del.

Otto Sperling havde set sig vel om i Verden og havde bl. a. været i Venedig, hvor han havde været ansat som *Botanicus* i Haven hos en Raadsherre Contarenus. Til ham skrev nu Sperling og fortalte om sin Udnævnelse samt bad, om han ikke vilde sende nogle sjældne Frø, endvidere skrev Sperling til en Guilielmo Boel i Lissabon og herfra fik han iblandt andet to Slags „af en sjælden indisk Væxt, kaldet *Herba viva,* som er saaledes beskaffen, at naar man rører nok saa lidet ved den med en Stok eller Finger, bevæger den sig straks, lukker sine Blade med stor Hastighed sammen og sænker sine Grene mod Jorden. Da jeg (Sperling) nu engang talte med Stat-

holderen derom, fik han Lyst til at se samme Urt og beskuede den med Forundring. Han berettede det til Kongen, og den fromme Herre kom ogsaa og kunde ikke noksom undre sig over denne sælsomme Bevægelse og over, hvorledes Væxten snart efter lukkede sine Blade op igjen og Grenene hævede sig fra Jorden." Senere foretog Sperling en Rejse til Spanien og besøgte den kongelige Have ved Buen Retiro. Han købte der „en Del Rødder" af en *Hyacinthus indicus,* hvis Blomster lignede Narcisser og tog dem med sig til Danmark, men han kunde ikke faa dem til at blomstre dèr.

Sperling har efter Samtidiges Udtalelser været meget bjærgsom og dertil paaholdende med sine Planter, saa at han end ikke overlod sine nære Venner noget uden klækkeligt Vederlag. Han udgav i Aaret 1642 sin *Hortus Christianæus,* hvori opførtes 1519 Navne paa Planter, som han dyrkede i Haven. Rottbøll siger herom: „Hvilke, dersom de end for de mange Afvexlingers Skyld formindskes til 1000 dog ere for den Tid et meget betydeligt Tal, og kunde ikke uden stor Flittighed, Kundskab og en vis Paaholdenhed i saa kort en Tid bringes sammen, besynderlig da iblant samme findes mange rare udenlandske Planter." Rosenborghavens Samling af Planter har været langt over Universitetshavens. Vi ser da ogsaa, at Simon Paulli i sin Viridaria varia 1653 optrykker Sperlings Liste, medens han ikke nævner Universitetshavens Samling.

Her et lille Udvalg af Planter, som dyrkedes i Rosenborg Have i 1642. De i Parenthes anførte Plantenavne er de nu anvendte.

Alcea vesicaria (Hibiscus trionum?), Alsine baccifera (Cucubalus bacciferus), Alnus nigra seu Frangula (Rhamnus frangula), Arbor vitæ (Biota orientalis), Aster marinus Dodon. Tripoliu (Aster tripolium), Capsicum americanum siliqu. oblong. tenuissima og 14 andre *Capsicum-Former (Capsicum annuum,* Spansk Peber), *Ceratonia Teophrasti s. siliqua (Ceratonia siliqua,* Johannesbrødtræ), *Chamelæa tricoccos (Cneorum tricoccum), Chelidonium majus officinar* og *Ch. maj. alterum fol. et floribus laciniatus* (Man har altsaa allerede den Gang haft den fligetbladede Form af Svaleurt under Kultur), *Chelidonium minus (Ficaria verna), Christophoriana (Actæa spicata), Colchicum autumnale tessellatum, Fritillarium dictum (Colchicum variegatum), Convolvulus non convolvulus Hispanicus tricolor (Convolvulus tricolor), Cucumis asinius (Ecballium agreste,* Æselsagurk), *Halicacabum officin. Alkekengi (Physalis alkekengi,* Jødekirsebær), *Herba mimosa Brasiliana (Mimosa pudica), Lachryma Jobi (Coix lacryma), Malus Punica (Punica granatum,* Granatæble). Af Narcisser opføres 33 Arter og Sorter i Listen, endvidere *Rapunculus hortensis fl. dilutiore pallido (Phyteuma spicatum)* og *Staphisagria (Delphinium staphysagria).*

Da en Del af disse Planter kun kan dyrkes under Glas, maa der nødvendigvis have været Væksthuse, det vides da ogsaa, at der i 1642

fandtes et forfaldent Blomsterhus i Rosenborg Have, og Sperling omtaler det (Æstuariet) ogsaa i sin Selvbiografi.

Det har været noget ganske nyt for Urtegaardsmændene at have saa mange forskellige Planter at passe, og Sperling har rimeligvis været vanskelig at tilfredsstille. Han klager gentagne Gange over Urtegaardsmanden David Königs Dovenskab og Uforfarenhed, og navnlig er der efter hans Udenlandsrejse 1641 udgaaet mange Planter saavel i Haven som i Æstuariet. At faa König afskediget lader sig imidlertid ikke gøre, da han ved at gifte sig med en Slægtning af Vibeke Kruse havde skaffet sig en høj Beskytterinde. I 1644 faldt Sperling selv i Unaade hos Kongen og afskedigedes fra sine Embeder. I hans Sted ansattes Helvig Dieterich som Bestyrer. Haven synes derefter, hvad angaar de botaniske Samlinger, at være gaaet i Forfald.

FREDERIK V. KONGELIGE BOTANISKE HAVE VED FREDERIKS HOSPITAL

FREDERIK V, som havde store Planer med Hensyn til Bebyggelsen af Arealet mellem St. Annæ Plads og Toldbodvejen, lod i Aaret 1752 Grundstenen lægge til Frederiks Hospital. Hertil skulde knyttes en botanisk Have, som kom til at ligge Nord for Hospitalet. Haven var gennemskaaret af Amaliegade og faldt saaledes i to Dele, en mindre, vestlig, 11,106 □ Al. og en større, østlig, 24,539 □ Al. Til Leder af denne Have var valgt Bayreren Georg Christian Oeder, som i 1752 ved J. H. E. Bernstorff var indkaldt her til Landet. Det var fra først af Meningen, at Oeder skulde have været ansat ved Universitetet, men da dette ikke lykkedes, udnævnte Kongen ham til *Medicus* paa Hospitalet og overdrog ham at paabegynde det berømte Værk „Flora Danica" samt lede den ny Have.

Havens første Gartner var Kristian Hansen, som fra 14. Maj 1753 var „Gartner ved den anlæggende Botaniske Have og ved det ny Kgl. Hospital paa Amalienborg" (Bestalling af 7/5 1753). Anlæggelsen af Haven skred kun langsomt frem. Dels var Oeder meget paa Rejse, og dels var det Terræn, Haven skulde lægges paa, ikke umiddelbart anvendeligt til Dyrkning af Planter; det maatte først fyldes op og bearbejdes. Omkring 1760 var den mindre Have bleven nogenlunde færdig, den større Have vedblev derimod at henligge uopdyrket, skønt der var rejst Mur udenom den saavelsom udenom den mindre. Ogsaa Drivhuse blev der bygget i denne Have, og i 1763 aabnedes den for Publikum.

Oeder var et stridbart Gemyt, han kunde heller ikke forliges med Kristian Hansen, som derfor i 1762 afskedigedes, men med fuld Gage: 300 Rd + 100 Rd. til Husleje. I hans Sted ansattes Friederich Christian Voigt som Gartner ved Haven (Bestalling 6/2 1762).

Havens Drift var imidlertid dyr, og i 1770 indkom Partikulærkammeret derfor med en Forestilling til Kongen om at gøre en Forandring gaaende ud paa at overlade den vestlige Del af Haven til Universitetet og den østlige til Kommerciekollegiet. (Se videre om Havens senere Skæbne under Universitetets 2den Have, S. 303.)

Ogsaa ved Sorgenfri Slot skal der have været en botanisk Have, om hvilken dog næppe noget historisk er levnet. I Parken voksede i sin Tid *Asarum europæum* og endnu findes *Phyteuma spicatum* dér. Begge disse Planter kunde tænkes at være Relikter fra den botaniske Have.

FORSTBOTANISK HAVE VED CHARLOTTENLUND OG DEN KONGELIGE VETERINÆR- OG LANDBOHØJSKOLES HAVE

INDEN der i 1863 paa Landbohøjskolen blev oprettet Kursus for Havebrugere og Skovbrugere, foregik Undervisningen i disse Fag andetsteds; Havebrugerne undervistes paa deres Læresteder, medens Skovbrugerne nød Undervisning paa den polytekniske Læreanstalt og blev examinerede af en Forstexaminationskommission, som i 1833 var bleven dannet med Jonas Collin som Formand. Denne Examinationskommission indsendte i 1838 et Andragende til Rentekammeret, i hvilket gjordes gældende, at den botaniske Have „ikke tilfredsstiller de Fordringer som et grundet Studium af Forstbotaniken gør til et sligt Anlæg, og at det derfor var nødvendigt, at et eget, i Omegnen af Hovedstaden beliggende Anlæg dertil bragtes tilveje," og der indsendtes derefter fra Rentekammeret allerunderdanigst Forestilling derom til Kongen.

En Kommission, bestaaende af Professorerne J. F. Schouw og Fallesen, Botanisk Gartner Mørch og Plantageinspektør Schäffer, blev nedsat for at bringe et passende Sted i Forslag. Stedet, der valgtes, var 8 Td. Land i det sydvestlige Hjørne af Charlottenlund Skov, og Planen til Anlæget blev udarbejdet af Gartner Mørch. Ved Jordens Bearbejdning, Opførelsen af et Hus for Opsynsmanden, Indhegning af Arealet og Beplantningen af Arboretet havde Kommissionen Bistand af Skovrider Riedewaldt. Udgifterne ved Havens Anlæg var beregnede til 1820 Rd. Kommissionen vedblev iøvrigt at bestyre Haven og ved Professor Fallesen og Gartner Mørchs Død blev disse erstattede med Forstdocent Hansen og Botanisk Gartner Weilbach; i Tidens Løb undergik Kommissionen flere andre Forandringer.

Da Forstundervisningen i 1863 blev henlagt til Landbohøjskolen, udtalte Ministeriet, at omend den forstbotaniske Have nu ikke mere var nødvendig til Undervisning i Forstbotanik, maatte det dog anses for ønskeligt, at dette skønne Anlæg bevaredes og udvikledes. Ministeriet mente videre, at Haven fremtidig kunde tjene som Forsøgsskole for Træer og Buske, der vilde kunne trives i vore Skove og tillige burde Træer og Buske, som havde Betydning for Havebruget, optages i Samlingen.

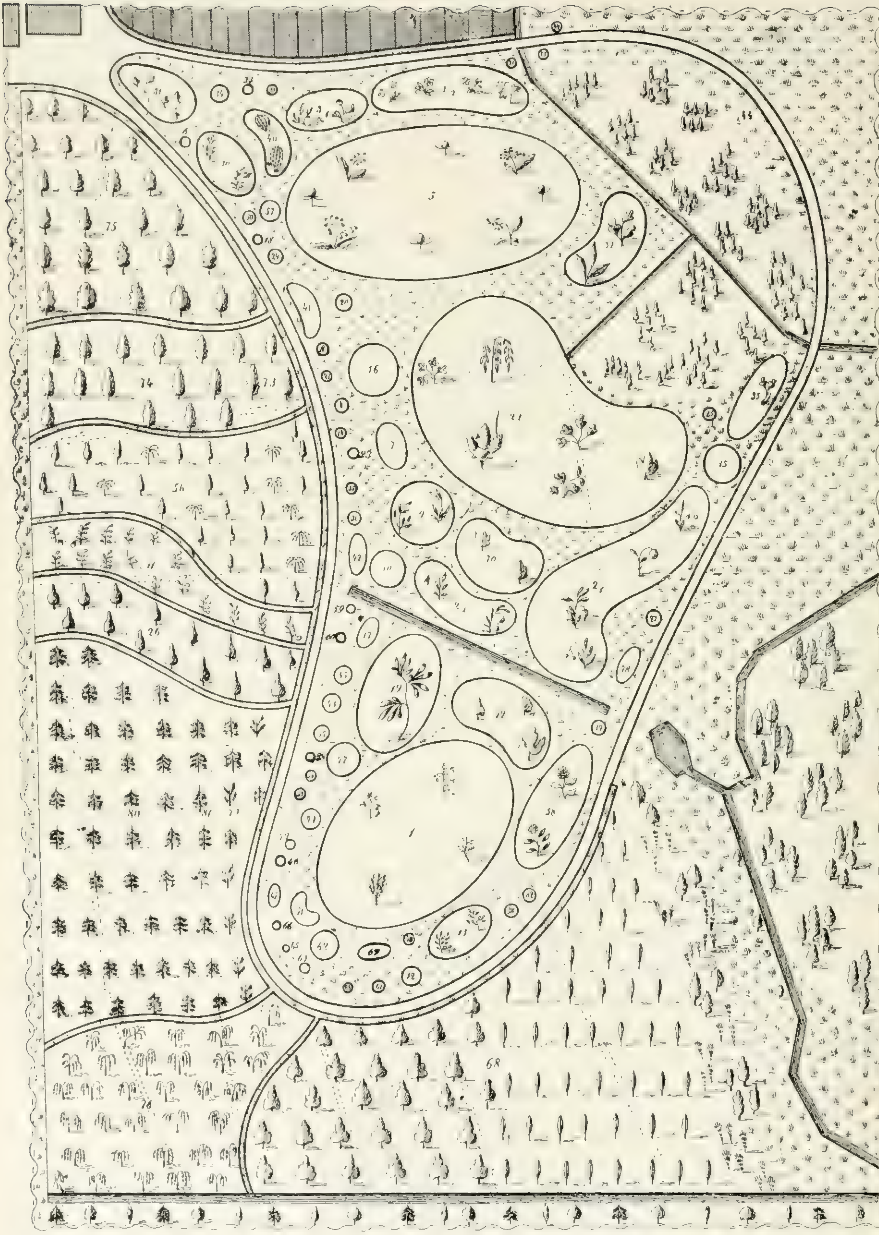


Fig. 143. Plan over Forstbotanisk Have 1847.

Et i den Anledning nedsat Udvalg — Overførster Eide, Professor A. S. Ørsted og Gartner Bentzien — udarbejdede en Betænkning, som blev indgivet til Ministeriet det paafølgende Aar. Udvalget tilraadede bl. a. en Udvidelse og Forøgelse af enkelte større Familier, især af Egene og Naaletræerne samt en Bortrydning af visse Bevoksninger i Havens Udkanter for at give Plads til andre Planter, som bedre kunde tjene Havens Formaal. Med Hensyn til Ministeriets Forslag om at anvende Haven delvis som Forsøgsskole for Skovtræer, mente Udvalget dette maatte indskrænkes til Iagttagelser over Træernes Haardførhed; ligeledes mente man for Havebrugets Vedkommende særlig at kunne anbefale Plantning af Træer og Buske, til hvis Haardførhed og Dyrkningsmaade man endnu ikke havde fuldt Kendskab. Haven tænktes lagt under det tilstødende Skovdistrikts Styrelse, men man formente det heldigt, at en Opsynsmand, som tillige skulde passe Haven, bibeholdt Bolig i denne. Udførelsen af de af Udvalget foreslaaede Arbejder bifaldtes af Ministeriet og det overdroges Bentzien at lede disse Arbejder samt at føre det fremtidige gartneriske Tilsyn med Haven.

Fra Landbohøjskolen fremkom nu imidlertid Forslag om, at Bestyrelsen af Forsthaven lagdes ind under Højskolen, og i Skrivelse af 27. Maj 1869 bifaldt Ministeriet denne Ordning. Efter dette Tidspunkt har Forstbotanisk Have været under samme Ledelse som Højskolens egen Have.

Ved Veterinærskolens Have paa Christianshavn havde der været en lille botanisk Have, hvor der dyrkedes Lægeplanter, men denne har aabenbart kun haft ringe Betydning.

Da nu Veterinær- og Landbohøjskolen i 1858 skulde oprettes under ny og rummelige Forhold, ønskede man ogsaa at give den en Have, som kunde danne en værdig Ramme om Skolen og tjene som et fyldigt Undervisningsapparat for Botaniken. Den Komité, der skulde udarbejde Planen for Havens Anlæg, bestod af Professorerne Fenger, B. S. Jørgensen og Joh. Lange, Konferentsraad Drewsen samt Gartnerne Bentzien og J. F. Koch. Det overdroges Bentzien at udarbejde en Plan til Haven (se Fig. 144). Fordelingen af Træer og Buske blev foretaget af Professor Lange med Bistand af Etatsraad Rothe og Botanisk Gartner Weilbach; Jordbehandlingen saavel som Beplantningen af Arealet blev foretaget af Gartner Wagenblast.

Da Undervisningen i Havebrug blev henlagt til Landbohøjskolen i 1863, blev der til den $7\frac{1}{2}$ Td. Land store botaniske Have lagt de 2 Td. Land, som endnu dyrkes som Frugthave og $1\frac{1}{2}$ Td. Land bestemt hovedsagentlig til Køkkenhavedyrkning.

Ved Tidernes Ugunst er begge Haver bleven beskaarne og delvis omlagte, værst er det i saa Henseende gaaet ud over Forstbotanisk

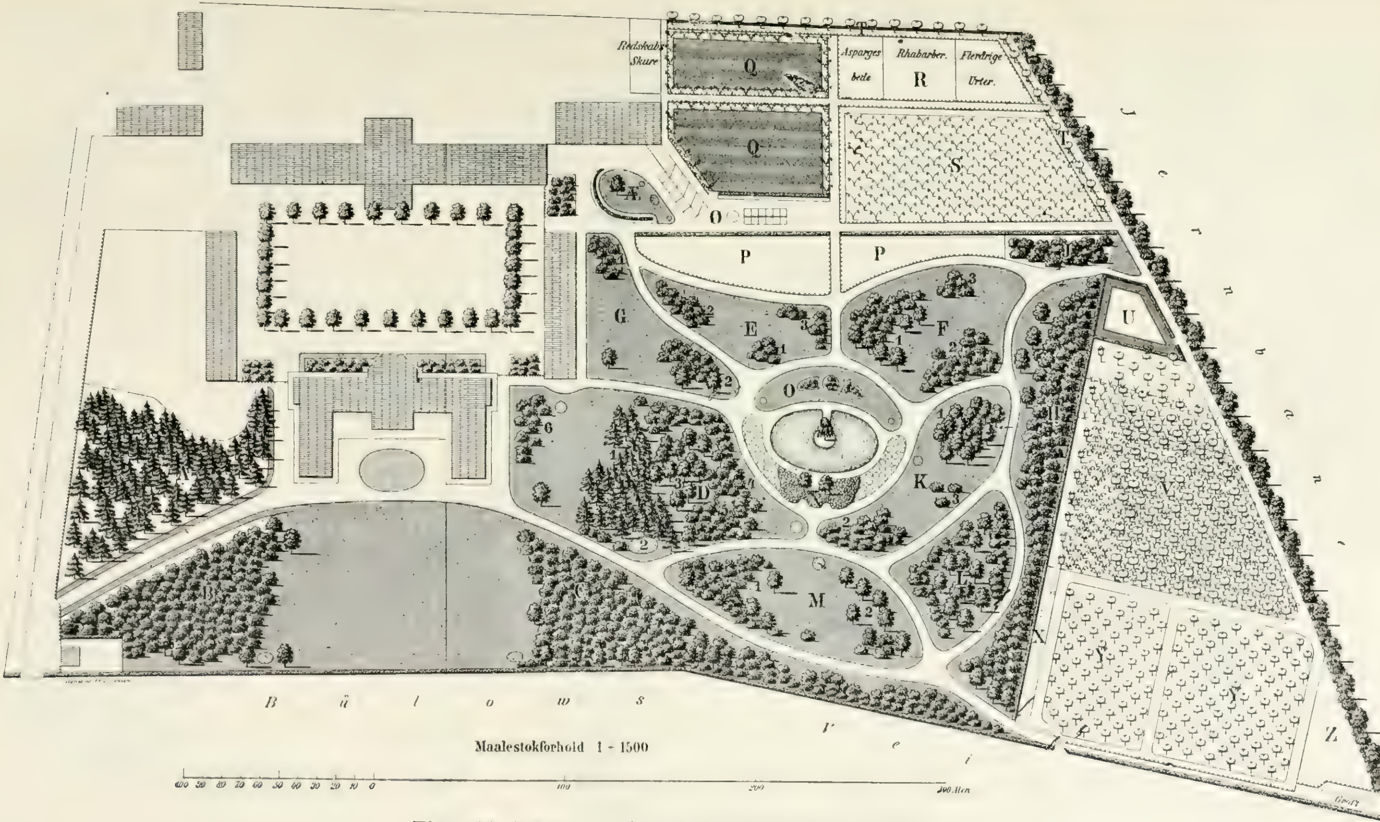


Fig. 144. Plan over Landbohøjskolens Have 1871.

Have. I 1895 maatte denne afgive $^1/_2$ Td. Land langs Vestsiden til Jærnbanestationens Udvidelse og samme Aar maatte den afstaa et smalt Jordstykke langs Nord- og Østsiden for at der kunde skaffes Plads til Anlæggelsen af en privat Vej. Landbohøjskolens Have mistede i 1892 et mindre Jordareal, fordi Højskolens Hovedbygning skulde udvides.

De to Haver har siden 1869 staaet under samme Styrelse. Først havde Skolens Botaniklærer den botaniske Del under sig, Havebrugsdocenten den økonomiske Have under sig, men senere overtog den



Fig. 145. Fra Forstbotanisk Have. Stenhøjen.

sidste Driften af begge Haverne, dog saaledes, at Botaniklæreren havde Indseende med Nyplantninger og Rydninger i Arboretet saavelsom med Ændringer i det urteagtige botaniske System. Haveassistenten var dels stillet til Raadighed for Havebrugslæreren, dels for Botaniklæreren, han havde Bolig i Haven og havde Tilsynet med den daglige Drift. I denne Stilling har en Række bekendte Havebrugere, nemlig Tyge Rothe, St. Nyeland, D. T. Poulsen, L. Helweg og Alfr. Bruun virket. I 1892 ansattes en fast Gartner, hertil udnævntes Alfr. Bruun, som skulde have den daglige Drift af Haven under sig med Ansvar overfor et Haveudvalg bestaaende af Lærere ved Højskolen. Da Bruun i 1902 blev Lærer ved Skolen, blev han tillige Efor for Haven og samtidig ophævedes Haveudvalget.

I Forsthaven blev der fra først af — som før nævnt — især plantet Ege og Naaletræer, af disse er yderst faa tilbage, og de store Naaletræer, som hører til denne Haves Seværdigheder, er for største Delen plantede 1864. Men i 80erne og i Begyndelsen af 90erne blev der

atter plantet en overordentilg Mængde Coniferæ, som daværende Docent Carl Hansen skaffede til Veje fra mange forskellige Steder.

Der er i Tidernes Løb i Forsthaven ført Bog over, hvad der er plantet, saaledes at man som Regel ved Besked om hvert enkelt Træs Alder paa Stedet. I 1845 rummede Forsthaven 332 Arter og 32 Varieteter, dette fremgaar af en Fortegnelse, som Botanikeren Kamphøvener, der paa det Tidspunkt vikarierede for Professor Schouw som Lærer for Skovbrugerne, udarbejdede og som foreligger trykt.



Fig. 146. Fra Forstbotanisk Have.

I „Fortegnelse over de i Veterinær- og Landbohøjskolens Have og i Forsthaven dyrkede Frilandstræer og Buske“ er opført 681 Arter og Varieteter, og i 1908 regnedes Tallet til c. 1000, hvoraf c. 300 var Naaletræer. Forsthaven er, trods sin bekvemme Beliggenhed, ikke særlig stærkt besøgt, dette skyldes sikkert udelukkende Ukendskab hos Publikum til Haven, men den har en fast Vennekreds, som sætter overordentlig Pris paa den og som vil beklage, om den i Fremtiden skulde blive nedlagt.

Landbohøjskolens Have nyder en stor Popularitet hos den frederiksbergske Befolkning, den er af en egen Hygge og Skønhed: den smukke Stenhøj, den lille Sø med den gamle Sørgepil, der ligesom danner hele Havens Midtpunkt, og de talrige Foraarsblomster, som myldrer frem under Arboretets Træer, virker særlig tiltrækkende paa Publikum.

Havens Arboret rummede i 1871 (ifølge Joh. Langes Liste) 899 Arter og Varieteter, medens i 1908 Antallet ansloges til 1020. Af Stenhøjs-

planter dyrkes nu 830 Arter og Varieteter, af Stauder 550 og af Bregner 53, endvidere af botaniske urteagtige Planter i Systembedene, i Skovbede, Mosebede, Sandbede og Lyngbede 630 Arter (alle disse Tal fra 1918). Planter under Glas findes dels i nogle mindre Bakker, dels i et ældre ensidigt Hus med to Afdelinger og et nyere Saddeltagshus; i det første af disse findes forskellige Varmhus- og



Fig. 147. Parti fra Landbohøjskolens Have. Stenhøjen og Dammen.

Koldhusplanter, i det sidste dyrkes særlig Florblomster som *Cineraria, Schizanthus* og *Chrysanthemum*. Af Væksthusplanter og Udplantningsplanter dyrkes 650 Arter og Varieteter, og af Sommervækster c. 580 Arter og Sorter.

Haven beskæftiger — heri indbefattet saavel den botaniske som den økonomiske Del — en fast Gartner samt af Medhjælpere og Gartneriarbejdere c. 9 Mand Aaret rundt.

BOTANISKE HAVER VED LÆRDE OG KOMMUNALE SKOLER

VED SORØ AKADEMI har der tidligt været anlagt en botanisk Have, idet Tyskeren Joachim Burser, som virkede ved Akademiet omkring 1625, har anlagt en botanisk Have. Om dens Anlæg, hele Liv eller dens Indhold af Planter ved man imidlertid yderst lidt. Lind skriver, at den oprindelig var Klosterhave og efter Bursers Tid har været benyttet af Apothekerne der paa Stedet for til Slut at gaa over til at blive Akademihave. I 1822 anlagdes atter paa Akademiets Grund i den saakaldte Plantagehave en botanisk Have paa en rektangulær Plads Vest for Gartnerboligen. Her dyrkedes et betydeligt Antal Frilandsplanter, og efter at der i 1829—30 var opført et Væksthus, blev der ogsaa dyrket Planter fra varmere Lande. Ved denne Tid var der ansat en Gartner, Hans Ditlev Nissen, ved Akademiets Have, han var i 1802 fulgt efter Carl Frederik Døllner, der i Aarene 1800—02 havde været Akademiets Gartner. Nissen drev ved Siden af sin Gartnergerning ved Haven en Del Handel med Planter, og formodentlig har der ligefrem været hjemlet ham Ret hertil for at bøde paa den sikkert meget ringe Pengeløn. Af Annoncer i „Statstidende" for den Tid ser man, at han har dyrket en ikke ubetydelig Mængde Træer og Buske med Salg for Øje. Efter hans Død 1834 afkøbte Akademiet hans Bo for 50 Rdl. en Del Potteplanter, som han efterlod sig.

Aaret forud var det blevet overdraget Lektor ved Akademiet Jacob Hornemann Bredsdorff at udarbejde en beskrivende Katalog over Havens Plantesamling. Det meget omfangsrige Værk, som er affattet paa Latin, blev afsluttet i Løbet af 3 Aar og indeholder Navne paa 1422 højere Planter, fordelte paa 665 Slægter. Det var fra først af Meningen, at det skulde trykkes, men dette naaedes aldrig; Manuskriptet forefindes i Sorø Akademis Bibliothek. Af Væksthusplanter dyrkedes dengang (1837) bl. a. *Begonia discolor, Ilicium anisatum, Justicia adhatoda* og 6 Kaktus-Arter.

Efter Nissens Død var F. A. Voetmann Gartner indtil 1880; han fulgtes af E. C. Thayssen, som atter i 1914 blev efterfulgt af den nuværende Gartner F. C. Lønow.

Omkring Aaret 1857 blev Sorø-Haven omlagt af R. Rothe, som

anlagde den nuværende Park; ved denne Lejlighed blev den botaniske Have henflyttet til en ret smal Strimmel Jord, beliggende mellem Danneskjolds Allé og Priorgade og her blev Planterne anbragte i Smaabede. Da Musæet i Slutningen af 90'erne blev opført paa en Del af denne Grund, blev den botaniske Have nedlagt. Der findes nu ingen botanisk Studiehave ved Akademiet; Materialet til Undervisningen i Botanik søges udenfor Terrænet. Haven og Omegnen bærer dog Spor endnu af, at der har været dyrket fremmede Planter, idet man dèr finder flere forvildede Planter (f. Eks. *Galinsoga parviflora, Myrrhis odorata* og *Oxalis stricta).*

Ved HERLUFSHOLM blev der i Aaret 1890 af Forstanderen udvist et Stykke Jord af „Store Granplantage" paa ca. 3½ Td. Lands Størrelse med det Maal for Øje dér at indrette et „Pinetum", d. v. s. en Samling af Naaletræer. Anlægget heraf ledede s af Adjunkt M. Traustedt, som sikkert ogsaa er den, der fra først af har taget Initiativet til Pinetets Oprettelse; men i denne Forbindelse maa Plantør Jacobsen paa Hæsede ogsaa nævnes, som en Mand, der ydede sin betydelige Del til, at Pinetet kom i Gang. I Aaret 1891 udkom en Beretning om Anlægget og en Liste over de Arter, som var saaede eller plantede og i en anden Beretning, udgivet i 1896, findes en udførligere, delvis beskrivende Liste, omfattende 164 Navne paa Naaletræs-Arter, hvoraf dog kun de 102 var repræsenterede, medens Resten for Størstedelen ventedes snarligt anskaffede. Desværre er den Plads, som i sin Tid blev valgt til Samlingen, meget uheldig; Pinetet er nemlig anlagt paa en Bakke med løst, stenfrit Sand, og Betingelserne for Træernes gode Vækst er derfor meget daarlige. Baade Traustedt, som ledede Pinetet til sin Død, og den nuværende Leder, Adjunkt J. Ferdinand, har vist stor Interesse for Pinetets Trivsel, og havde der været gode Jordbundsforhold til Stede, er der ingen Tvivl om, at der vilde være bragt noget ganske udmærket ud af Samlingen; denne rummer, trods de daarlige Kaar, talrige smukke Træer og tæller nu ca. 200 Arter og Varieteter.

Til Skolen hører ogsaa et botanisk System, hvor der dyrkes omkring 550 Arter. Endvidere findes der, ligeledes tjenende den botaniske Undervisning, et lille Parti med Plantesamfund (Klit-, Hede-, Mose-Planter) samt et betydeligt Stenhøjsparti, anlagt omkring Skolens Sceptictanks under Ledelse af Adjunkt Ferdinand. I disse Partier dyrkes over 1000 Plantearter. Fra Herlufsholms botaniske Have uddeles der gratis Planter til andre Skoler og til Private; den aarlige Uddeling andrager 200 à 300 Eksemplarer.

Endnu kan nævnes, at der muligen allerede i Slutningen af det 18. Aarhundrede har været en skolebotanisk Have i ODENSE. Peder von Westen har 1782 udarbejdet: „Plan og Charte til en botanisk

Haves Anlæg ved Odense Gymnasium"; denne Plan findes ikke paa vore større Biblioteker, og om Haven er bleven til Virkelighed, kan ikke oplyses.

Forskellige Seminarier og Skoler her i Landet har i den nyere Tid i umiddelbar Tilknytning til Institutionerne udlagt mindre Arealer som skolebotaniske Haver. Her at gøre Rede for alle disse Haver, vilde dog føre for vidt, der skal blot kortelig gives Oplysninger om den vigtigste af Provinsens botaniske Haver, nemlig:

DEN SKOLEBOTANISKE HAVE I AARHUS

I 1905 blev der af „Jydsk Forening for Naturvidenskab" paa Forslag af cand. mag. P. Obel indgivet et Andragende til Aarhus Byraad om at indrette en skolebotanisk Have af en saadan Størrelse, at samtlige Skoler kunde forsynes derfra med Materiale til Brug ved Undervisningen i Botanik. Det blev overdraget Lærer Poul Larsen at udarbejde en Plan for Anlæggelsen og Driften af en saadan Have, idet der samtidig hertil blev anvist et Stykke Jord paa 1700 Kv. Al. i „Jydsk Haveselskabs" Have. Gravning og Dræning af Jordstykket besørgedes ved Haveselskabet, ligesom dette de følgende Aar lod udføre Gravning og Lugning; Stykkets Tilplantning og Tilsaaning udførtes af Poul Larsen, og i de følgende Aar paatog samme sig ydermere Udlevering af Planterne til Skolerne. Da Haveselskabets Have senere overtoges af Aarhus Kommune udvidedes Skolehavearealet til 4000 □ Al. Skolehaven staar dog vedvarende under Lærer P. Larsens Ledelse.

I Haven findes nu ca. 300 Arter af de almindeligste Blomsterplanter, og det paatænkes at lade plante de danske Buske og Træer.

Skolernes Benyttelse af Haven foregaar væsentlig paa den Maade, at der Sommeren igennem med 2 à 3 Ugers Mellemrum tilstilles Skolerne en Liste over, hvilke Planter, der er i Blomst eller Frugt, og efter denne Liste rekvirerer Botaniklærerne Materiale til Undervisningen. Udlevering af bestilt Materiale foregaar hveranden Dag i 2 Timer. Antallet af Portioner, d. v. s. saa meget Materiale af hver Art, som anses nødvendigt til en enkelt Elev, er i Løbet af den Tid, Haven har eksisteret, vokset fra 4000 til 14,000. Haven besøges ogsaa af Lærere og Elever under Tilsyn i de Timer, da Skolehavens Leder er til Stede.

PRIVATE BOTANISKE HAVER

MANGE Privatpersoner har i Tidernes Løb næret saa megen Interesse for Botanik, at de i deres Haver har anlagt Samlinger af Planter, hvorfor disse Haver med en vis Ret har kunnet betegnes som botaniske. En Grænse, mellem hvad der kan regnes for en botanisk Have og hvad der blot maa betegnes som en Plantesamling, synes vanskelig at drage. De i det følgende nævnte Haver kan dog maaske nævnes blandt de bekendteste af saadanne private, botaniske Samlinger.

Klavs Urne, Domprovst i Lund, havde ved sit Herresæde Beltebjerg i Skaane, anlagt en „besønderlig Urtegaard", som Henrick Smid omtaler med Berømmelse i 1546.

Rottbøll omtaler, at Grev Johann Ludvig af Holstein paa „sit kiere Ledreborg" lod indrette en Botanisk Have, „som med saadan en Hurtighed blev indrettet og forsynet med Planter, at den paa 2 Aar var stegen mere end til 1200 Planter og pralede af en utallig Mængde *Aloes, Cacti, Mesembryanthema, Euphorbiæ, Gerania, Hibisci, Malvæ, Solana* etc." Disse Planter var for Størstedelen ved Professor K. Friis Rottbøll forskrevne fra Holland. Andre Planter, som var mindre kælne, var anbragte i Bede paa Friland, ordnede systematisk.

Ved Slottet FRYDENLUND fandtes i Slutningen af det 18. Aarhundrede Samlinger af nordamerikanske Træer og Buske og de Coninckerne plantede i Haven ved DRONNINGGAARD ligeledes talrige sjældne træagtige Planter.

Ved Slottet AALHOLM paa Lolland blev der i ældre Tider plantet et Arboret, som endnu i Slutningen af 1860'erne var ret righoldigt. I 1867 har Botanisk Gartner Weilbach i „Tidsskrift for Havevæsen" givet en Skildring af dette Arboret. Det fremgaar heraf, at Arboretet paa Aalholm er plantet i Tiden fra 1796 til 1814, medens en anden Del er plantet i Tiden 1830—1835, da Chr. Gentz var Gartner ved Slotshaven. En Del af Arboretet kaldtes „Systemet", hvor Træerne har været plantet i Rækker hver Slægt for sig og saaledes synes at have haft en ren botanisk Ordning. I Weilbachs Be-

skrivelse af Aalholm-Arboretet er optaget ca. 100 Træer og over 50 Buske; han havde dog kun medtaget de vigtigste Arter eller største Eksemplarer; en Del af Arterne kunde ved hans Besøg dèr ikke identificeres. I ældre Tider har Samlingen været langt righoldigere. Det fremgaar af gamle Lister over Indkøb af Planter, at Haven har faaet meget righoldige Samlinger fra Booth's berømte Planteskole i Flotbeck. Indkøbet begynder i 1829 og kulminerer 1831. Sidstnævnte Aar blev bl. a. købt 30 store Plataner, over 150 *Quercus coccinea,* 100 *Pinus nigra,* 29 *Pinus tæda* o. m. a. Planter i stort Antal, foruden adskillige Hundrede Arter og Former i enkelte Stykker. I Følge „Dansk Haugetidende", 1. Aargang, 1849, omfattede Samlingen i 1833 ikke mindre end 1500 forskellige Træer og Buske.

Noget senere — henimod Midten af det 19. Aarhundrede — er Haven i SNOGHØJ, som ejedes af Generalkrigskommissær Riegels, en i Plantedyrkning særdeles interesseret Mand, bekendt for sine Samlinger af Træer og Buske. I samme Tidsperiode har GJORSLEV HAVE paa Sjælland righoldige Samlinger af Frilandsplanter.

Apotheker GUSTAV LOTZE, der virkede i Odense, nærede en dyb Kærlighed til Havebrug og Botanik og samlede i sin Have ikke alene talrige sjældne Træer, men anlagde ogsaa store Stenhøje med righoldige Samlinger af Alpeplanter. I Væksthusene, der havde en samlet Længde af 100 m og hvis Palmeafdelinger maalte 10 m i Højden, havde han samlet tropiske Nytteplanter og andre Planter fra de varme Lande, navnlig Orchideer.

Blandt private botaniske Haver bør HÆSEDE PLANTESKOLE ikke forbigaas, idet den i al Fald i sin Tid var ganske enestaaende i sin Art.

Planteskolen var anlagt i Hæsede Skov, nærmest med det Formaal for Øje at forsyne Gisselfeld Have med Planter; men efter at Hans Jacobsen i Midten af 30'erne i forrige Aarhundrede som ganske ung Mand havde faaet Planteskolen at passe, fik denne efterhaanden sit særlige Præg. Jacobsen, der var kommen til Pladsen uden særlige Forkundskaber, erhvervede sig ved sin Virken som Plantør og ved sine flittige Studier meget omfattende Kundskaber paa Botanikens Omraade, og da han var Samler om en Hals, fik han bragt mange sjældne Træer og Buske til Veje og snart forsynede han andre Planteskoler, botaniske Haver og Herregaardshaver med Plantemateriale af sin Rigdom. En Vandring gennem Planteskolen, især i Følge med Jacobsen, var overordentlig lærerig, og endnu huser Planteskolen, selv om den har mistet noget af sit Præg, store Planteskatte.

Dr. F. BØRGESENS Have i Hellebæk udmærker sig særlig ved sine smukke Samlinger af Naaletræer — her findes f. Eks. et Eksem-

plar af *Sequoia sempervirens,* et Træ, som ellers ikke vil trives paa Friland hos os — ved sine prægtige Stenhøje og sine Samlinger af Smaabuske. Stenhøjene rummer meget rige Samlinger af saavel Primler og Stenbræk som højnordiske sjældne og vanskelig dyrkelige Arter af *Cassiope, Juncus* og *Diapensia* samt tillige mange Frilandsbregner og Orchideer. Blandt Smaabuskene indtager *Cotoneaster, Berberis* og *Rhododendron* den mest fremragende Plads hvad Artsantallet angaar; af den sidstnævnte Slægt findes 64 Arter, et saa stort Antal Arter kan sikkert ingen anden nordisk Have for Tiden



Fig. 148. Fra Dr. Børgesens Have, Hellebæk.

opvise. Nævnes kan ogsaa, at der af *Daphne* dyrkes 9 og af de nyzelandske, buskagtige *Veronica* 5 Arter.

Mag. art. M. LORENZEN, Stettemark, Holte, har i sin Have anlagt storslaaede Stenpartier med rige Samlinger af Alpeplanter. Mag. Lorenzen samler endvidere Buske og mindre Træer, af de første findes 564, og af Træer 254 Sorter og Arter. Af egentlige urteagtige Alpeplanter dyrkes i denne Have ca. 700 Arter, Hybrider og Varieteter, deraf 100 *Saxifraga* og 100 *Primula,* dertil 70 Smaabuske og Dværgbuske. Paa Stenhøjene er der endvidere 24 *Anemone*-Arter og forskellige finere Løgvækster, medens der andetsteds i Haven er plantet 100 Arter og Sorter af *Crocus.*

Lolland besidder nuomdage to Privatarboreter. Det ene findes paa

KNUTHENBORG, i hvis over 500 hekt. store Park flere sjældne Træer er plantede, ofte i et betydeligt Antal Eksemplarer. Denne Park er under Overgartner J. K. Jørgensens Ledelse.

Det andet lollandske Arboret findes paa HARDENBERG. Her er der mere l[illegible]t an paa et større Artsantal; det mindre Areal, som her raades over, begrænser ganske naturligt Individantallet.

De vigtigste Træer i Hardenberg-Arboretet af nogen betydelig Størrelse er plantede omkring 1840, andre for omkring 40 Aar siden. Endelig er der i Tiden fra midt i 90'erne og op til den nyeste Tid indkøbt mange sjældne og smukke træagtige Planter, saavel Naaletræer som Løvtræer, bragt til Veje af den for Samlingerne saa stærkt interesserede Overgartner Chr. Jørgensen.

I Samlingen findes en over 100-aarig *Corylus colurna,* 11 m høj, en ca. 80-aarig *Liriodendron tulipifera,* 17 m høj, 40-aarige *Pinus peuce, Magnolia Soulangeana, Prunus lusitanica* og *Thuyopsis dolabrata;* en 210-aarig *Tilia platyphylla,* 26 m høj, en 25-aarig *Picea omorica,* 6 m høj og af samme Alder en *Liquidambar styraciflua,* 6 m høj, endvidere *Cedrela sinensis* og *Gymnocladus canadensis.* Af Naaletræer findes ca. 200 Arter og Former, fordelte paa 23 Slægter, deraf har *Abies* alene 31 og *Pinus* 38 Arter og Former. Af Løvtræer findes op imod 850 Arter og Former, fordelte paa 177 Slægter. Som særlig rigt repræsenterede Slægter kan nævnes *Cratægus* med 33, *Prunus* med 25, *Quercus* med 39, *Spiræa* med 64 og *Acer* med 37 Arter og Former.

LITTERATUR-FORTEGNELSE

Vigtigste Literatur: Otto Sperling: Hortus Christianæus 1642. — Joh. de Buchwald: Specimen medico-practico botanicum, 1721. — Skrifter som udi det kjøbenhavnske Selskab af Lærdoms og Visdoms Elskere ere fremlagte (Rottbøll) 1770. — J. W. Hornemann: Om den Kgl. bot. Haves nærværende Forfatning (i Athene) 1813. — F. Thaarup: Nogle Bidrag til det Kbh. Universitets bot. Haves Historie (i Telegraphen) 1826. — Fr. Weber: Hortus Kiliensis, 1822. — L. Engelstoft og E. C. Verlauff: Udsigt over Kjøbenhavns Universitetsbygnings Historie, 1836. — F. Thaarup: Materialer til den danske Stats Havekulturs Historie 1843. — F. Didrichsen: For hundrede Aar siden (i Naturhistor. Tidsskrift) 1869. — Beretning om Univervitetets paatænkte nye Botaniske Have, 1870. — Ratjen: Geschichte der Universität zu Kiel 1870 — Joh. Lange: Fortegnelse over de i Veterinær- og Landbohøjskolens Have og i Forsthaven .... dyrkede Frilandstræer .... 1871. — Joh. Lange: Erindringer fra Universitetets Botaniske Have ved Charlottenborg (i Botanisk Tidsskrift) 1875. — H. Matzen: Universitetets Retshistorie 1879. — J. C. Jacobsen og Tyge Rothe: Beskrivelse af Væxthusene i Universitetets botaniske Have, 1879. — Birket Smith: Dr. Otto Sperlings Selvbiografi, 1885. — Holger Hansen: Den botaniske Have ved Amalienborg (i Historiske Meddelelser om Kjøbenhavn, 3. Bind. — Den Kongelige Veterinær- og Landbohøjskole 1858—1908, Festskrift (Alfr. Bruun: Haverne) 1908. — J. Reinke: Der älteste Botanische Garten, Kiels, 1912. — Forskellige Aargange af Badens Universitetsjournal, Engelstoft: Universitet og Skole-Annaler, Selmers Akademiske Tidender, Lindes Meddelelser; Goos, Matzen, Munch-Petersen: Aarbog for Kjøbenhavns Universitet; Chronik der Universität zu Kiel. — Have-Tidende. — Dansk Hauge Tidende. — Tidsskrift for Havevæsen. — Gartner-Tidende. — Akter fra Rigsarkivet (Sjæll. Miss. 374 (1770), 1441 (1777) 615 (1779), 239—41 (1788), Partikulærkammerets Ordreprotokol 1770.

Resumé of the section »Botaniske Haver« from Svend Bruun og Axel Lange: Danmarks Havebrug og Gartneri til 1919, Kbh. 1920.

Botanical gardens in the sense we now apprehend the notion were not known until the year 1545, when the university of Padua founded such an institution. Other universities followed suit, thus gardens were laid out in Bologna 1568 and in Leiden 1577. It will be seen, that the universities had the leadership in this regard, but later on royal as well as imperial, municipal and private gardens were founded.

THE FIRST BOTANICAL GARDEN OF THE COPENHAGEN UNIVERSITY
(HORTUS MEDICUS)

In the year 1600 a new residence for a professor was to be erected close to the university of Copenhagen, and on this occasion the king Christian IV endowed to the university a site on which was to be laid out a botanical garden. This garden had no gardener, neither had it any income; the professor who was assigned to the lodging was bound to keep the garden in proper order. No alteration took place in these respects until Rasmus Casper Bartholin in 1696 presented the university with 1200 Rigsdaler, the interest of which should be used to buy seeds and to pay a gardener.

We do not hear much of the garden during the coming $^3/_4$ of a century; in 1719 the plants of the gardens have been transplanted under the guidance of Johannis de Buchwald and arranged alphabetically; after the great conflagration of Copenhagen in 1728 the garden is reduced in size because of the regulation of the adjoining streets, and about the middle of the 17th century we hear that a gardener is attached to the institution for very modest wages.

THE SECOND BOTANICAL GARDEN OF THE COPENHAGEN UNIVERSITY
(OEDERS GARDEN)

The garden was really too small for the purpose, and the king, who took a certain interest in the garden, and who in 1769 had endowed it with 2500 Rigsdaler, promised to enlarge it with some

adjacent gardens. This plan was not carried out, but the king resolved instead that a much larger botanical garden, which had been founded by Oeder under protection of the late king (Frederic V.) in another part of the town (at Amalienborg) should be given to the university. This garden measured about 11000 squarefeet ground, it was well furnished with plants and in a good order. Rottboll, professor of botany and medicine at the university, had to take the charge of the garden and as curator was appointed J. W. Kæsemacher, a skilful gardener, who had spent some years in the Amsterdam-garden.

Only a few years the garden was allowed to remain here. Neither was the soil so good as it ought to be, nor the situation owing to lack of shelter.

THE THIRD BOTANICAL GARDEN OF THE COPENHAGEN UNIVERSITY

(CHARLOTTENBORGHAVEN)

The king therefore presented the university with a new site for its garden namely the garden of Charlottenborg. Furthermore he rebought the Amalienborg-garden for 6000 Rd. The removal began in 1778, and in 1787 the professor Rottboll and the privy counsellor Holmskjold who had arranged the new garden, were able to report to the king, that the buildings had been completed as proposed.

On this new site the botanical garden, which had a size of 3 Td. Land ($1^1/_2$ hektare), stayed for about 100 years, although the trustees of the institution soon were aware that it really was too small. Already in 1803 the wealthy privy counsellor Classen offered a fine site, rather large (4 hekt.) in the eastern suburb of the town, where the garden would have good conditions to thrive; but as the expenses by the transfer would be too enormous, the plan was abandoned. Now the garden was under the necessity of enlargement on the spot and really in 1811 it succeeded in obtaining an adjacent garden, and in the year 1844 again it obtained an extension; after this the garden measured about $4^1/_8$ Td. Land (2 hekt.), in which size it remained unaltered until its removal in 1871.

After the death of Kæsemacher in 1780 Niels Bache had the curatorship until 1793, when F. L. Hollbøll, the most skilful curator of the garden, was appointed to the post. He remained in the situation until his death in 1829 and was succeeded by O. J. N. Mørch who died in 1842. After Mørch A. Weilbach was curator during 26 years, and his successor was Th. Friedrichsen. The directorship was in the earlier time of the garden in the hands of a commitee consisting of Rottbøll and Holmskjold; later on four persons had their seat in the commitee until 1817. Till this year the institution had partly been under the university and partly under royal protection

but was now fully laid under the university, and from this juncture the directorship has been attached to a single person. Famous botanists as E. Viborg, M. Vahl and J. W. Hornemann have had their seat in the directory. Hornemann was the first solo-director, in 1841 he was followed by J. Fr. Schouw who again in 1852 was succeeded by Liebmann. After his death in 1856 Joh. Lange became the director of the garden.

The garden was well sheltered in its situation in the old royal garden, several plants were thriving well here and the garden was on the whole of a certain snugness. But it had several defects. Chiefly it was still too small and the desire to get it removed, was permanently increasing. Furthermore the soil was partly too gravely and bad, and partly excessive rich in mould; the houses that had been partly rebuilt in 1843 were not spacious enough. In 1856 Curator Weilbach therefore very opportunely published a note in one of the principal newspapers (Fædrelandet) about the necessity of a renaissance of the garden on a new and more spacious site. But about 20 years should elapse, before a new garden was fulfilled, and Weilbach should not live to see his plan realized.

THE FOURTH BOTANICAL GARDEN OF THE COPENHAGEN UNIVERSITY

(THE PRESENT GARDEN)

Being fully aware of the bad circumstances for the garden the university in the year 1857 and after the desire of the government took the initiative to form a committee that should make investigations how and where to form a new garden. This committee consisted of Johan Lange the director of the garden, Jap. Steenstrup, and J. G. Forchhammer, professors of the university. With different alterations and augmentations it worked until the garden in 1874 was finished on its present seat and it had during these years several difficulties to conquer. Very soon it was evident to the committee, that the best situation would be some part of the fortifications of Copenhagen, that were destined to be demolished within a few years.

In 1871 this seat was finally accepted for the purpose, and the same year 25000 Rigsdaler were granted to preliminary labours. The committee that now consisted of professor Johan Lange, professor A. S. Ørsted, the university-bursar Gjede, the brewer J. C. Jacobsen and the curator of the garden Th. Friedrichsen, had already in 1870 issued a statement: „Beretning om Universitetets paatænkte nye Botaniske Have“ mostly intended as an information for the members of the parliament, and in which therefore was given a brief narrative of the history of the garden and the special reasons why a new garden was desirable. A plan (fig. 132) that followed this report showed

some details of the intended garden. This report caused a lively discussion in the garden-periodical: „Tidsskrift for Havevæsen“ about the site of the garden, the application of the ground, the construction of the houses and the design of the garden on the whole.

It was from some hand viz. the lecturer in horticulture at the veterinary and agricultural college J. A. Dybdahl proposed to abandon the present plan and to lay the garden close to the veterinary & agricultural college; but at all events he found it necessary to have an expert in landscapegardening to enter the committee.

The government did not wish to alter the site of the garden, but on the other hand it willingly entered on the proposal to add some new members to the committee and in accordance herewith the landscapegardener H. Flindt and the royal gardener Thyge Rothe were summoned as counsellors, the former should work out a new plan and the latter was charged in connection with J. C. Jacobsen to give new plans for the houses.

In the years 1871—74 the garden was fulfilled in correspondence with the new plans at cost of 642,000 Kroner, and the 1 of june 1874 the garden was delivered in the hands of the directory of the garden, and the committee consequently dissolved. The garden was opened to the public 9. Oktober 1874.

The garden in form an irregular square, had by its foundation an area of $9^3/_4$ hektares. It consists of a larger lower part holding the 9000 square-meter large lake, towards the east and southeast the ground rises rather abruptly against the boulevard and the observatory, situated outside the garden at the highest point of the mount (13 m.); towards the south and west the ground-elevation is more even and soon the surface is quite level; on this plateau the museum, the lodges for the curator and foremen and the laboratory are situated.

The trees and shrubs are disposed all over the garden after a systematically point of view, and from the beginning the perennials were dispersed in the same way. In the western corner of the garden a little grove was planted to illustrate the north-american silva. In the centre of the garden the rockery was laid out on twinhills attaining a hight of 13—14 m., from whence a splendid view can be had over the garden and the surrounding town. The greenhouses cover an area af 2400 sq. m. and have a volume of 12000 m^3, and the glass-area is 3100 m^2; a greater part of the houses has two layers of glass. The highest point of the palm-house has an elevation of 19 m. In front of the houses is a basin with a fountain, flanked by two spanroofed houses. Also a water-lilyhouse, propagating houses, pits and forcing-frames are found in the garden. The warmingapparatus of the houses is based upon steamheating; the annual amount of coal consumed is about 400 tons.

The committee that had arranged the garden had proposed the

museum to be built at the same time as the greenhouses, nevertheless its erection was pestponed until 1875 when the parliament granted 112,000 Kroner for the purpose: a sum which really was too limited, for which reason the museum had to be built on a smaller scale as intended, to immense disadvantage and drawback for the institution during its existence.

Johan Lange, who had been director for the garden about 20 years and had been the chairman in the committee during its latter years, was in 1875 succeeded by F. Didrichsen, who held the office until 1885, when Eug. Warming took his place. Warming came to the garden just at a time when the botanists of Denmark earnestly were wishing to get a laboratory for plant-anatomy and plant-physiology, and these efforts resulted in the erection of the botanical laboratory. This was built in the western corner of the garden, on which occasion the garden in itself was diminished in area with 1/3 hekt. and at the same time the northamerican arboretum had to be demolished. The building was fulfilled in 1890 at the cost of about 200.000 Kroner.

Now professor Warming devised a scheme for a biological garden, and in order to get room for this the area of the students' garden was reduced to half its size.

The polytechnicum that in the end of the 80ers had been built close to the botanical garden and was inaugurated in 1890 was soon getting too small for its purpose and the institution therefore wanted to extend upon the domain of the botanical garden. In compensation for the 0,3 hekt. the polytechnicum wished, the garden should have on rent in 50 years an adjacent municipal area of 0,7 hekt. extent. The garden entered upon the proposal and hereby it was enabled to get some improvements on its own ground. Wiz: the perennials could be removed to a better quarter of the garden instead of being spread about in the lawns. At the same time the garden gave a freer admittance for the public as formerly. Prior to these alterations the curator Th. Friedrichsen took his leave in 1902 after having been in activity for 34 years: he was succeeded by Axel Lange. And by the expiration of 1911 prof. Warming retired and was followed by C. Raunkiær.

The staff of the institution consists of: the director managing the whole establishment with exception of the physiological laboratory that is under the guidance of another university-professor (at the present time professor W. Johannsen) with his assistant. At the botanical laboratory is appointed an assistant and a door-keeper. The museum and library has a museum-superintendent, a librarian, an ammanuensis, a conservatrice and a museum-official: the plants in the garden are revised by the garden-ammanuensis. The garden itself is under the guidance of the curator with the help of 3 foremen and

2 subforemen, 3 stokers, 4 guards and 20 gardeners and workmen; the number of work-days during the year amounts to 7000.

In the previous lines four different gardens have been mentioned, but of course these gardens may be regarded as a single garden — the garden of the university — and while we above have described the topographical, economic and personal circumstances of this institution we shall now shortly regard on what lines the garden has been working, of what use it has been and how the plant-collections have increased or altered during the days past.

In its earlier days the garden was a mere students' garden in which on the first line indigenous plants were cultivated, and furthermore it was a pleasure-garden for the professor occupying the residence. Ole Worm brought several foreign plants to the garden for instance *Rheum rhaponticum*, *Scorzonera hispanica* and *Mimosa pudica*. J. de Buchwald in 1720 issued a book with a description of a little more than 200 plants: „Specimen medico-practico-botanicum" which book the year after was translated into german by his son B. J. Buchwald; however, the translation does not agree fully with the original not even in respect to the plants mentioned. Corresponding with the plants described, dried specimen of the species are mounted on white pages of the book. Allthough we can not take as granted, that all the plants embodied have been cultivated in the garden (thus *Viscum album* and *Lathræa squamaria* have hardly been grown), we dare suppose, that the greater part of them have been to be seen there, and presumably other plants not mentioned have also been cultivated. Of plants not indigenous embodied in the book shall be mentioned: *Antirrhinum majus*, *Cannabis sativa*, *Cnicus benedictus*, *Cucumis sativus*, *Cyclamen europæum*, *Juniperus sabina*, *Lilium candidum*, *Physalis alkekengi* and *Veratrum album*.

The size of the collection of plants while the university had its garden at Amalienborg is not known, the garden took possession of the large collections, that Oeder had brought together, these embraced in 1763: 1500 species. In the Charlottenborg-period the number of species increased from 2855 (in 1784) to 9500 (in 1857) and now the garden can boast of 12000 species distributed over 2570 genera. The composition of the collection has altered during times past, changing after the taste of man or after the interest that the leaders of the institution have paid in the different sort of plants. We know, that Holboll in 1803 bought 25 different *Ericas* and that he the same year cultivated 40 species of *Mesembrianthemum;* in the time of Mørch (1839) the garden had 75 species of the latter genus and at the same time 35 *Acacias*, 50 *Pelargoniums*, 10 *Begonias*, 17 *Primulas* and 27 *Saxifragas*, while the collection now (1918) embraces 28 *Mesembrian-*

themums, 13 *Ericas*, 25 *Pelargoniums*, 15 *Acacias*, 64 *Primulas*, 65 *Begonias* and 100 *Saxifragas*. In 1834 the garden had only 3 tropical Orchids, now the number is 180.

The garden has always had in its possession specimens of plants, that could be regarded as prominently noteworthy on account of their age, their size or their rarity. The centre-plant in the palmhouse a *Phoenix spinosa* has in 1807 been brought to the garden and has now attained a height of 18 m. The *Livistona chinensis* (figured on page 326) was in 1919 cut down because it was getting too big, it had a total weight of 615 kg and carried the year mentioned not less than 15 kg of fruits. In 1904—06 an *Arenga saccharifera* flowered and subsequently died as is the nature of this plant; it had an age of 75 years. Several times *Agave americana* has been brought to flower and in 1836 Mørch had this species in flowering state exhibited to the public. He had bought the plant in Skaane (Sweden) and it was carried to Malmo by 8 horses and from that place sailed to Copenhagen. Of rarities in the open air, the *Eriolobus trilobata* (figured on pag. 328) ought to be mentioned.

Although the garden now and then has received collections from travellers or collectors in foreign countries, still it is keeping or increasing its stock mainly through its correspondence with botanical gardens abroad, especially by exchange of seeds. The garden yearly receives 2000—3000 lots of seeds and distributes about 11000 (average of 5 years) half of these are distributed to gardens connected with schools in Denmark.

In the year 1795 Holbøll started a kind of registration of the plants cultivated in the garden, a scheme that has been followed since then and which will enable us to tell the history of each plant in the garden.

The garden is still what it has been from the beginning a scientific garden and in accordance herewith the greater part of it is reserved to the students in the forenoon. On the other hand the garden must also be regarded as a promenade park, and after 1 oclock the public is allowed to pass all over the garden. Figures tell that about 1,400,000 persons pass the gates during the year; although several of these only hasten through the garden to and from their working place, surely the garden is by many people regarded as a blessing for this part of the town.

The „biological garden" where the plants have been arranged after characters and qualities, is especially destined to serve public instruction. Just to the same purpose the palm-house is opened for the public each day (1—5) in the summertime. Special collections have during the years been exhibited for the public, thus for instance in 1915 a collection of Begonias was to be seen here, and in 1918 a collection of Commelinace's and Arace'es was arranged in the hothouses.

The garden has during its existence been the seat for experiments planned out by the botanists or by the garden-curators. Thus curator Mørch tried to feed silkworms with substitutes for the leaves of *Morus alba* and found, that *Ulmus americana* gave the best result. Curator Weilbach planned out experiments with heavy glass for greenhouses and with air circulation in greenhouses in the purpose to give the plants more natural conditions. Dr. Samsø Lund and Kiærskou have carried out investigations upon the cabbage species. In the latter years professor W. Johannsen, C. Raunkiær and C. H. Ostenfeld have planned different experiments.

Although we here speak of the garden itself, a few notes about the institutions connected with it, will be of some value. The museum embraces collections of plants in alcohol, samples of wood and seeds and first of all the herbariums. These containing c. 475,000 sheets consist of 3 main divisions namely the universalherbarium, the danish and the arctic herbarium. The library to which admittance can be had 3 times the week, contains c. 20.000 volumes.

SORØ ARBORETUM

About the expiration of the past century an arrangement took place between the Sorø forests and the botanical garden of Copenhagen in accordance with which the garden should rear trees and shrubs to be planted in the Sorø forests on grounds that could be spared. Since 1903 different conifers and a large collection of *Cratægus* have been planted near „Filosofgangen" while a selection of *Acer* has been put down in „Feldskov".

THE BOTANICAL GARDEN OF KIEL[1])

The university of Kiel erected in 1665 by the duke Christian Albrecht, received in 1669 from this prince a botanical garden and the planning out of this was intrusted to the medicinal professor Johan Daniel Major. The work he had undertaken lasted about 4 years full of trouble and vexations for the poor Major. In 1773 another medicinal professor Nikolaus Pechlin had to overtake the directorship. The garden soon declined and it seems that it did not exist after the year 1684.

A new *hortus medicus* was shortly after 1720 erected near the university-building. The apothecary Christiani pledged himself against the payment of 10 Rdl. the year to cultivate the ground and grow different medicinal plants and furnish the professors with material for their lectures on botany.

In 1802 a new hospital with surrouling garden was erected in the

[1]) Until 1864 Holstein was united with the danish kingdom.

town build by professor Georg H. Weber from voluntary contributions. This garden was in 1807 put under the guidance of his son Friederic Weber. The curator Peter Höhle was appointed from 1806 until 1831. Twice the garden was enlarged and had in 1822 an area of about $2^1/_2$ hekt. ($4^2/_3$ Td.) The greenhouses were built partly at the start in 1802 partly in 1816 and 1820. The collections were rather large, in 1822 about 6000 species. Ferdinand Nolte succeeded Weber as director of the garden and about 1855 C. Dahle was curator there.

ROYAL BOTANICAL GARDENS IN DENMARK

In 1606 the king Christian IV. bought a number of gardens situated outside the town and here in the years 1610—24 he erected the famous castle Rosenborg. The garden to this castle was rather spacious and the king found it desirable here to make a botanical garden, and in consequence herewith such a one was laid out and in the year 1638 put under the guidance of dr. O. Sperling. This botanist was a very industrious and energetic man and soon brought together a large collection of plants; his „Hortus Christianæus" of 1642 that contains 1519 names of plants bears witness of this, and in this respect his garden surpassed the garden of the university. The curator of this part of the Rosenborg garden David König has not been capable to manage the large collection, and Sperling expresses his discontent herewith. A selection of plants mentioned in „Hortus Christianæus" is given on page 337; the names mentioned in brackets give the names now used. Several of these plants were to be grown under glass and we also know that Sperling has had greenhouses for this purpose. In 1644 Sperling fell into royal disgrace and as his successor did not pay any special interest in the botanical garden, this soon decayed.

Frederic V. King of Denmark had the intention to erect a splendid quarter of the town and in connection herewith he founded 1752 a hospital and a botanical garden. The latter consisted of two parts measuring 11.106 □ al. and 24.539 □ al. divided by a broad street. The famous botanist G. C. Oeder was designed to govern this garden and the first curator was Kristian Hansen. About 1760 the smaller garden was finished; the greater one never came to fulfilment although a wall had been built all around the ground. Greenhouses have been in the garden and in 1763 it was opened to the public. As it turned out to be too expensive for the king to keep this garden the smaller piece of ground was presented to the university. (See further about this garden on page 1).

THE FORESTIAL-BOTANICAL GARDEN IN CHARLOTTENLUND AND THE GARDEN AT THE AGRICULTURAL COLLEGE

Before the year 1863 no instructions were given at the agricultural college to horticulturists and foresters. The former received instruction where they were apprenticed, the latter took lessons at the polytechnicum and were examined by a commission with Jonas Collin in the chair. This commission proposed in the year 1838 to lay out a smaller arboretum close to the metropolis and in consequence herewith an area of 8 Td. (c. 11 acres = 4 hekt.) in the southwestern corner of Charlottenlund forest was destined for the named purpose. This garden was rearranged in 1863 at which epoque the forestry-studium was transferred to the agricultural college, and since the year 1869 the forest-garden has been put under the same college.

The old veterinary-college had a small garden where medicinal herbs were grown, but this garden has been of no significance. In 1858 when the veterinary college was removed and enlarged to an agricultural college, a garden was laid out around the buildings. This garden was planned out by A. Bentzien, while the selection of plants was made by professor Joh. Lange assisted by R. Rothe and Aug. Weilbach. In 1863 when the course for horticulturists was put under the institute, the garden was enlarged with an orchard.

Owing to the frowns of fortune the two gardens here mentioned have been limited in area; thus in 1895 the forest garden in Charlottenlund had to make over $^1/_2$ Td. area to the railways and in 1892 the agricultural college was enlarged, and the garden must yield the necessary area.

Since 1869 the two gardens have been under the same guidance; this charge was firstly put in the hands of the lecturers of botany and horticulture, later on under the latter alone and in 1892 the gardener of the institution took over the curatorship; as curator Bruun in 1902 became a professor he was at the same time designed to be director (eforus) of the garden.

BOTANICAL GARDENS AT GYMNASIUMS AND MUNICIPAL SCHOOLS

At Soro-academy a garden existed in the time of Buser (about 1625). 1822 a new garden „Plantagehaven" was laid out close to the curator's lodge. In 1837 not less than 1422 species were cultivated in these grounds.

At Herlufsholm an area of $3^1/_2$ Td. was laid out in the year 1890 to a pinetum, designed by Traustedt. Here more than 100 species and varieties of conifers were grown about 1896. The soil is

rather bad, but nevertheless the collections are of great interest. To the college also belongs a students' garden containing 550 species.

In Aarhus a municipal-garden was established in 1905. Its purpose is to furnish the schools of the town with material for the instruction in botany. 300 different species are cultivated and about 14000 shares of plant-material are distributed in the year.

PRIVATE BOTANICAL GARDENS

Different persons have shown so much interest in botany that they have formed their gardens partly as botanical collections. Klavs Urne in Lund (the 16th century) and Johann Ludvig Holstein at Ledreborg (the 18th century) have to be mentioned in this respect, and Lotze, apothecary in Odense had in the middle of the 19th century large collections. An arboretum at Aalholm was started in the end of the 18th century and was partly renewed about 1830. In our days interesting arboretums are to be seen at Knuthenborg and Hardenberg. Private collections of alpine plants and shrubs are kept by mag. Lorenzen, Holte and dr. F. Børgesen, Hellebæk.

THE STRUCTURE AND BIOLOGY OF ARCTIC FLOWERING PLANTS

14.

Liliales.

By

Morten P. Porsild.

1920.

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Hitherto, the following papers have been published in "Meddelelser om Grønland":

Vol. XXXVI:

Vol. XXXVII:

Of the order **Liliales** several species, belonging to different families, advance to the arctic limit of forest occasionally even crossing it, not attaining, however, a wider distribution in the arctic territory where they do not belong. We find also that they in the alpine regions do not, or only occasionally, cross the limit of forest, cf. remarks in Schroeter: Pflanzenleben p. 354—5.

The principal of those species are the following:

1) **Veratrum album** L. and the closely related **V. viride** Ait. extend respectively in the river-valleys of Northern Eurasia and Northern America to the coasts of the Arctic sea.

2) **Streptopus amplexifolius** (L.) D. C. is an E. Asiatic —N. American forest plant; the fruit is a berry, and it has probably, through the agency of birds, been brought to the subarctic copses of the southernmost part of Greenland.

3) **Lloydia serotina** (L.) Sweet — closely related to *Gagea* — advances on both sides of Bering's strait farther into arctic territory than any of the others. Thus it is found at Cape Lisburn and extends even as far as the purely arctic New Siberian Islands.

4) **Allium schoenoprasum** L. (including **A. sibiricum** L.) is found in the island of Kolgujew, in the river-valleys of N. Asia up to the Arctic sea, and on the north coast of Alaska.

5) **Iris sibirica** L. (and related species?) extend to the coast on both sides of Bering's strait.

As to the structure and biology of the majority of the above-mentioned species the reader is referred to KIRCHNER, LOEW & SCHROETER's: "Lebensgeschichte" where — on Alpine material — these questions have recently been treated.

Widely distributed in the arctic territory are only the two following species of the genus

Tofieldia:

1) **T. palustris** HUDS., circumpolar, common from the subarctic territory far into the arctic, probably without reaching the purely high-arctic regions, however.

2) **T. coccinea** RICH., N. Asiatic, N. American, found besides in the northernmost two-thirds of Greenland, everywhere rare or perhaps overlooked; numerous of its Asiatic occurrences are only known from previous erroneous determinations, corrected by OSTENFELD (Fl. Arctica p. 32).

A third species: *T. calyculata* WAHLENB. is distributed throughout nearly all the mountain regions of Central Europe, whence it often descends into the lowland, whilst it only in a few places crosses the Alpine limit of forest: the variety *glacialis* REICHENB.

The structure and biology of *T. calyculata* is extremely well-known, and the same applies partly to *T. palustris*. An account of this, based upon Alpine material, is found in LOEW & KIRCHNER's: "Lebensgeschichte" p. 229 ff., a copious literature being quoted here, too. Cp. also the description of the closely related *Narthecium ossifragum* HUDS. ibid. p. 244 ff., and RAUNKIÆR p. 138 ff. The following observations,

having all been carried out upon arctic, living and alcohol material, chiefly from Greenland, will therefore serve mostly as a complement, especially with regard to the least known of the species: *T. coccinea.*

Occurrence in nature. *Tofieldia palustris* and *T. coccinea* grow on moist spots among heath- and bog vegetation, more rarely on fresh plantless moraines. They occur most frequently here as firm cushions or cakes which are held together by the vigorous secondary roots (Fig. 1, *A*). They attain their highest development when growing among bog-mosses. Here the leaves become longest, and the floral shoot tallest, but on the other hand, the stalks are able to creep better and more widely, and consequently we do not get here as large and firm cakes as otherwise. The habitats are covered by snow during winter.

The shoots are short-jointed, flat, frequently erect, more rarely, through want of space, obliquely ascending and, in vigorous specimens, each shoot bears from 6—8 leaves. During several years the shoot remains on a purely vegetative stage until finally ending in an inflorescence. Some of them remain on the vegetative stage. Structure of shoot cp. Fig. 1, *A—D.*

The leaves are all uniform, apart from a slight difference in length, the lowermost being the smallest, evergreen, two-rowed ensiform, equitant with a long sheath. Below the green leaves some withered ones (often black-spotted by fungi) are found, and at the base setaceous, vascular strands are seated originating from older marcescent leaves. Scale-leaves are not found. The lateral shoots are formed in the uppermost axils of the leaves, normally only one or two are developed.



Fig. 1.

A, *B*, *C*. Structure of shoot in *T. palustris* (Finse, Norway).

A. Habit drawing of two flowering shoots which only cohere by the aid of the roots. *b*, the scape with its sheath-formed bract.

B. The main-shoot, *I*, has two withered leaves (*1*—*2*) and six fresh (*3*—*8*). In the axil of *2* a shoot: II, is to be seen, and in the axil of *3* another one *II*, of which 4 leaves are visible. Magnified, detailed drawing of it in the following (*C*).

C. Shoot with its subtending leaf: *f*, and with 3 leaves marked *1*, *2*, *3*, *4*. *1* and *2* turn their back to the mother-axis.

D. *T. coccinea*. Foliage shoot with withered remains of leaves, from unfavourable habitat. (Dove Bay, E. Greenland; leg. A. Lundager, 27. 6. 1908).

E. Germination in *T. calyculata*. (Drawn by E. W.)

In *T. coccinea* there is as a rule 9(—11) vascular bundles (Fig. 2), in *T. palustris* 11(—13). In the first-mentioned the leaves are often more flaccid (Fig. 1, *D*), frequently partly decumbent, especially in exposed places, whilst they, in the latter, always are rigidly erect.

The structure of the leaf is in all essentials identical in the two species. The sheath is constructed like a normal leaf, above this the leaf is isolateral, has an equal right and left side, an upper and lower margin (Fig. 3). The epidermis consists, except on the upper (inner-) side of the sheath, of rather small cells, the walls of which are slightly undulating, highly thickened, porous and covered by a well-developed cuticle which also spreads to the guard-cells of the stomata (Fig. 3 *B*, *D*). The stomata are arranged longitudinally, their slit is quite diminutive, the intercellular cavity beneath them is quite small. The base of the sheath consists of hyaline parenchyma; a little higher up, on the morphological lower side, we find the chlorophyll tissue consisting of several layers of cells, whilst the upper side is constantly non-chlorophyllose. Above the sheath the chlorophyll tissue is homogeneously developed on both sides, the non-chlorophyllose part occupying the centre of the leaf, extending right to the tip of the leaf (Fig. 2, 3, *A*, *B*). In contradistinction to *Narthecium* (vide RAUNKIÆR) no air-chambers are found in the chlorophyll layer on transverse sections.

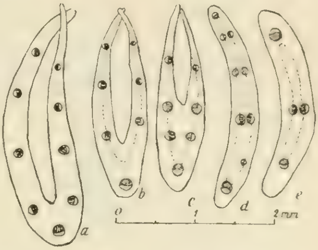


Fig. 2. *T. coccinea.* Nordre Strömfjord, Greenland. *a—e* show sections in various height through a foliage leaf. The xylem of the vascular bundles is dark. The dotted line shows the boundary between the chlorophyll tissue and the aqueous tissue; *a*, showing the basal part of the sheath, has no chlorophyll. (Drawn by M. P. P.)

The cells in the chlorophyll tissue are parallelepipedic and frequently no intercellular spaces are seen in transverse sections; in longitudinal sections, however, quite small ones are to be seen. The cells of the chlorophyll tissue contain chlorophyll grains filled with starch. In the isolateral part the vascular bundles approach by twos to each other, and the uppermost one is entirely connated of two (Fig. 2 *e*, 3 *A*). In transverse sections the large, crescent-shaped coverings of bast are to be seen.

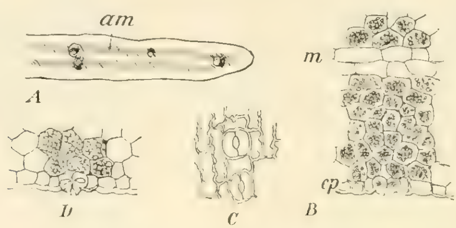


Fig. 3. Anatomy of leaf.

A, B, C. *T. palustris*; from Jakobshavn, W. Greenland.

A. Transverse section of a foliage leaf above the equitant part. The hatched *am* is the chlorophyll tissue; the epidermis and the central aqueous tissue are light.

B. A part of the same section, more highly magnified; *ep.* Epidermis with thick cuticle and a stoma with very minute air cavity. Chlorophyll tissue almost without any intercellular spaces, the cells filled with starch; *m* aqueous tissue.

C. Epidermis with two stomata, longitudinally placed. The walls of the cells are highly thickened, slightly undulating.

D. Transverse section of a leaf of *T. coccinea* (Danmarks Ø, E. Greenland leg. N. Hartz). (Drawn by E. W.)

The scape of inflorescence is as a rule leaf-less, yet in vigorous specimens 1—2 leaves may be found, the uppermost one at least having the character of a bract (Fig. 1). In *T. coccinea* 2—3 stem-leaves are nearly always present (Fig. 4 *A*), the uppermost one having, in this case, less of the character of a bract.

The inflorescence in *T. palustris* is nearly always a globular head (Fig. 1 *A*), more rarely a subcylindric spike. In *T. coccinea* the elongated spike is the normal form, the globular the rarer one (Fig. 4 *A*, *B*), but it varies according to the quality of the habitat. In *T. coccinea*, moreover,

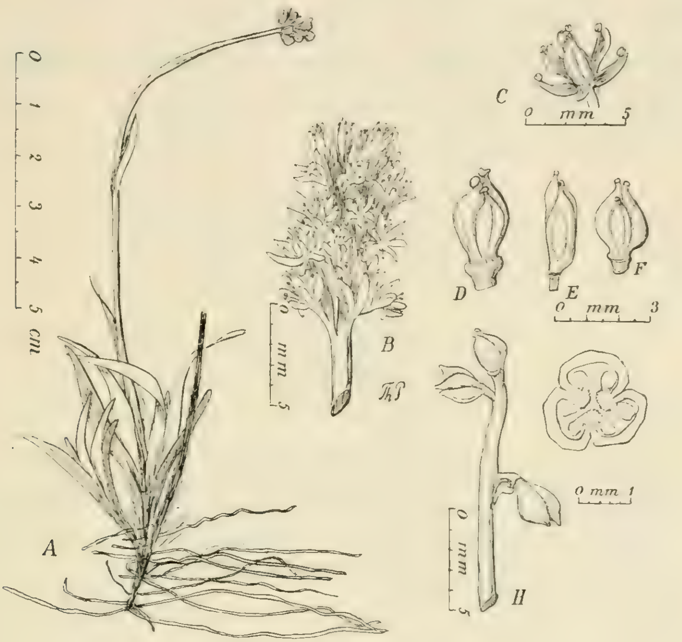


Fig. 4. *T. coccinea.* Nordre Strömfjord, Greenland.

A. Habit-drawing of a weakly flowering specimen growing in *Sphagnum*.
B. Inflorescence of a more richly flowering specimen.
C. Single flower, shortly before the hermaphrodite stage.
D, *E*, *F*. Almost ripe fruits in various positions; *D* and *E* the same specimen; note the asymmetry.
G. Transverse section of the ovary.
H. Uppermost part of the inflorescence, showing the downwards-directed carpotropic curvature, characteristic of the species. (Drawn by Thorbjørn Porsild).

single isolated flowers are frequently to be found below the spike, just as in *T. calyculata* and in other species of the genus.

The flowering season is the middle of the summer, consequently the species do not belong to the earliest flowering. In an average year they will, on the latitude of Disko, be out from the end of July, and then flowering specimens are to be met with all through the rest of the summer, because the floral shoots from the same tuft are not all of them developed simultaneously.

Under each flower a small 3-dentated bractlet is present which often envelops the peduncle. In *T. palustris*

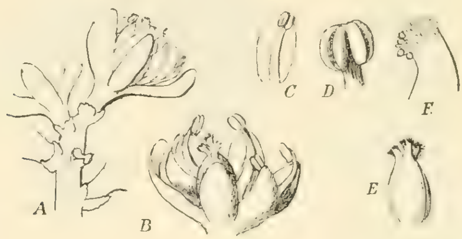


Fig. 5. *T. palustris* (Norway.)

A. Part of inflorescence; note the small, 3-dentated bractlet.
B. Flower at the beginning of the hermaphrodite stage: the stamens arise from the spoon-formed perigonial leaves.
C. Stamen in a perigonal leaf when the flower bursts.
D. Anther with open valves.
E. Carpels in the stage of pollination.
F. A single carpel, more highly magnified, showing pollen-grains on the stigma. (Drawn by E.W.)

it is always shorter than the peduncle (Fig. 5 *A*), in *T. coccinea* just as long as this or longer (ABROMEIT). In the latter a fairly well-developed "calyculus" is as a rule present, a bi-symmetrical whorl of 3 small leaf-formations of which one is turned outwards, the other two transversal (Fig. 6). The morphological interpretation is uncertain. In *T. palustris* it is normally absent, but may also, according to ABROMEIT, occur occasionally.

Diagram. Eichler's diagram of *T. calyculata* shows, besides the zygomorphy in the calyculus, a slight irregularity in the mutual size of the carpels. This also applies to the arctic species, especially to *T. coccinea* (Fig. 6), where it appears to be even more strongly developed than in Eichler's diagram. This difference is undoubtedly connected with the carpotropic movements (see below).

In *T. palustris* the perianth is purely white, or with a greenish rather than a yellowish tinge, in *T. coccinea* it is purely white on the inner side, deep purplish on the exterior, especially along the median line of the leaves. Also the upper part of the scape and the carpels are of a beautiful purple-red colour. This bi-colouring is in live specimens very conspicuous, and when the species grow together they are easily distinguished from each other by the colour of the flowers alone. But in herbariums the red pigment often disappears entirely, the flowers in both species becoming yellowish, hence the numerous confoundings and erroneous determinations.

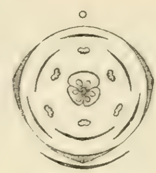


Fig. 6. Floral diagram of *T. coccinea.* Note the asymmetry in the carpets. (Drawn by M. P. P.)

The biology of the flowers (Fig. 5 *B*—*E*, 4 *C*) has been studied by H. Müller in the Alps on *T. calyculata* which he found proterogynous, while *T. palustris* was almost homogamous. In spite of a greater abundance of honey-secretion in the latter he found a greater number of insects visiting the former. Greenlandic flowers of *T. palustris* and *T. coccinea* were almost homogamous with a slight indication of proterogyny. Visiting insects I have never seen there. In *T. palustris* Müller draws the stamens as freely projecting in the flower, in Greenlandic living material the filaments were curved downwards into the cavity of the perigonial

leaf (Fig. 5 *B*, *b*, 4 *C*), this was especially prominent in the case of *T. coccinea*. During calm weather the cavity of the perigonial leaf is filled with pollen. When the flower has been open for some time the filaments, as well as the perigonial leaves, start curving upwards, and then the introrse anthera cannot avoid touching the stigmas. Thus cross-pollination is possible, but self-pollination the rule.

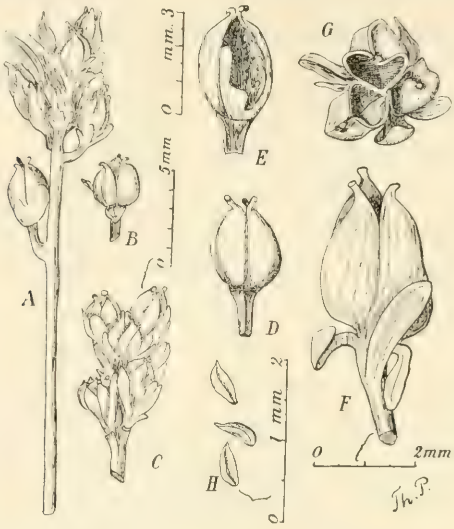


Fig. 7. *T. palustris* (Disko, Greenland).

A. Hibernated inflorescence with upwards-directed capsules, characteristic of the species.
B. Single, complete fruit of the same.
C. Almost ripe inflorescence gathered late in autumn.
D. Fruit, almost ripe, but not yet open. (The perigonial leaves removed). Note the almost perfect symmetry, as against *T. coccinea.*
E. Hibernated capsule with walls partly fallen off, typical for the species. Some seeds are still seated on the placentas.
F and *G.* A "normally" opened fruit (a rare case in the species). *F.* in moist condition. *G.* dry, seen from above.
H. Seeds. (Drawn by T. P.)

After the pollination the inflorescence, which hitherto has been slightly nodding, straightens itself up, and the

scape becomes rigid. The head or spike is stretched a little (Fig. 7 *A*). The perigone withers, but persists for a long time round the carpels (Fig. 7 *C*). In *T. palustris* the capsule is ovate, often a little brownish in colour and bent upwards (as in *T. calyculata*) (Fig. 7 *A*, *C*), whilst it in *T. coccinea* is shorter, subglobose and bent downwards (Fig. 4 *H*). The lowest fruits in the inflorescence bend right downwards parallel with the scape, the uppermost obliquely downwards or the top one only horizontally. This carpotropic movement begins immediately and is continued during the ripening of the fruit.

The ripening of the fruit is very late. Even on Disko, that lies far to the south of the Polar limit of the species, it is very difficult, even after favourable summers to find ripe fruits in the autumn, and if the unripe fruits are brought home the ripening is not continued. Exceptionally I have, however, found single, quite ripe fruits of *T. palustris* late in the autumn; the dehiscing is septicidal, forming a slight opening so that the seeds might be shaken out (Fig. 7 *G*). I have had no chance of seeing *T. coccinea* late in autumn. The majority of fruits in *T. palustris*, and probably also in the other, do not thus attain to ripen their fruits before the snow comes. Consequently the ripening must take place under the snow. I have looked through a large material of hibernated fruits of both species and only succeeded in finding a single "normally" opened fruit. Instead, the very thin capsule-walls had gone to pieces, and the seeds had got out through the holes which had come into existence in that way. Often the capsules may be quite "skeletonized" so that only the backs of the carpels are left (Fig. 7 *E*).

Sernander („Spridningsbiologi" pag. 354) has gathered *T. palustris* with seeds in the capsules in spring at the time when the snow was beginning to melt, and he therefore includes

them among the winter-standers. To a certain extent this is right, as it does not attain to ripen its fruits till the snow comes, and consequently may happen to spread its seeds on the snow. But the white, paper-thin capsules of *Tofielda* are to a less extent adapted to this than for instance, the *Luzula* species, the brown capsules of which are saturated with a substance which makes them proof against the various attacks of the first winter and preserves their hygroscopicity.

What brings about the skeletonizing of the *Tofieldia* capsules, I do not know. If it had been effected by mechanical wear of drifting snow in the spring-time there would always be found some which had been lying in sheltered places and remained intact. The apertures are irregular, as if the thin parchment-like capsular membranes had, through iterated freezing or exsiccation, become so fragile that even the slightest touch was enough to cause the apertures.

The production of seeds is no doubt abundant in both species, judging by the number of well-developed ovules and by the occurrence of the species in nature. Vegetative propagation is practically excluded, because even the strongest stream issuing from melting snow would hardly be able to break asunder the cakes which are made up of the strong roots felted together. Only in loose growing mosses a liberation of the lateral shoots takes place when the rhizome dies away at the back.

The seeds (Fig. 7 *H*) in *T. palustris* are small, yellow, a little triangular and slightly curved, with few wrinkles faintly marked on the testa. They weigh 0.03 mg. In *T. coccinea*, of which I have gathered but a few seeds in hibernated capsules, they were of about the same size and appearance.

Germination. The first stages have been seen by KLEBS (quoted in "Lebensgeschichte") and later on by WAR-

MING in *T. calyculata* (Fig. 1 *E*). After having emerged from the testa the cotyledon is geniculate bent, and at a very early stage a whorl of roothairs is produced at the base of the young root. The later stages are not known, but they might agree with those in *Narthecium* described by BUCHENAU.



Fig. 8.

A. Seedling of *T. palustris* at the end of the second period of vegetation.
B. 3—4 years old seedling of the same species. Both from Disko, Greenland.
C. Retarded inflorescence, extricated from an almost withered specimen of *T. coccinea*; g. small vegetative lateral shoot. Nordre Strömfjord, Greenland. (Drawn by Th. P.)

Seedlings (Fig. 8) are easily found in nature, but it is very difficult to find the very first stages because they are so small. The earliest formed foliage leaves wither rapidly, and the young plants pass through a period of strengthening, which lasts for many years, before they attain to flowering.

BIBLIOGRAPHY.

ABROMEIT, J.: Botanische Ergebnisse der von der Gesellschaft f. Erdkunde .... ausgesandten Grönlandsexpedition. Phanerogamen. Bibliotheca Botanica 42. 1899.

LOEW, E. und KIRCHNER, O.: Tofieldia in KIRCHNER, LOEW u. SCHROETER: Lebensgeschichte der Blütenpflanzen Mitteleuropas Lief. 14. Stuttgart. 1911. In this work an extensive bibliography is found.

MÜLLER, H.: Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassungen an dieselben. Leipzig 1882.

RAUNKIÆR, C.: De danske Blomsterplanters Naturhistorie I. Kjøbenhavn 1895—99.

SCHROETER, C.: Das Pflanzenleben der Alpen. Zürich 1908.

SERNANDER, R.: Den skandinaviska florans spridningsbiologi. Upsala 1901.

Besides, I have made freely use of notes and drawings by Professor E. WARMING.

TYP. BIANCO LUNO. KBHVN.

ORCHIDACEAE TÉNIANAE YUNNANENSES

VON

FR. KRÄNZLIN
WOLFENBÜTTEL

Sonderabdruck aus Fedde, Repertorium XVII (1921), pp. 99—112

Arbejder fra den botaniske Have i København. Nr. 95

XXXI. Orchidaceae Ténianae Yunnanenses[1].

Von Fr. Kränzlin (Wolfenbüttel).

Arbejder fra den botaniske Have i København. Nr. 95.

Herr Dr. C. Christensen in Kopenhagen hatte die Freundlichkeit, mir die Orchidaceen anzuvertrauen, welche Herr Siméon Tén gesammelt hat. Es sind im ganzen 41 Arten, von denen 13 neu sind; leider sind wieder 6 davon Habenarien. Die im vorigen Jahre erschienene Arbeit des Herrn Dr. R. Schlechter über die Orchideenflora des japanisch-chinesischen Florengebietes, welche in Feddes Repertorium Beiheft IV veröffentlicht ist, war in erster Linie zu berücksichtigen, sodann die Flora of Hongkong and Kwantung von Dunn and Tutcher. Das erstgenannte Werk mußte ich wegen einer ganzen Anzahl Meinungsverschiedenheiten stärker berücksichtigen. Der Verf. hat geglaubt, in Arbeiten, die ich vor 20—25 Jahren geschrieben habe und denen zum großen Teil sehr dürftiges Material zugrunde lag, eine Anzahl Fehler aufdecken zu müssen, was an und für sich berechtigt, löblich und für die Wissenschaft nur förderlich ist. Obgleich ich Kontroversen dieser Art grundsätzlich aus dem Wege gehe,

[1]) Alle hier aufgezählten Exemplare sind Originale des Bot. Mus. Kopenhagen. Fedde.

hat die hier vorliegende Arbeit mich doch öfter, als mir lieb war, genötigt, meine früher vorgetragene Ansicht zu verteidigen, was mir, wie ich hoffe, gelungen ist, ohne den Boden der Sachlichkeit zu verlassen.

1. **Cypripedilum yunnanense** Franchet in Journ. de Botan. VIII (1894) 231. — Yun nan. In silvis La pa ho, Pe yen tsin. (Siméon Tén sine no.!)

2. **Spiranthes sinensis** (Pers.) Ames Orch. II (1908) 53. — Yun nan. Pe yen tsin. (Siméon Tén no. 1256!)

„Nomen vernac. Long pao tschou, quod significat. (Long) Draco (pao) amplectens (tschou) columnam.“

3. **Epipogum aphyllum** Swartz, Summa veget. Scand. (1814) 32. — Yun nan. Ta (?) tsin teon. Prope unum fontem. (Siméon Tén no. 1332!)

4. **Neottia camtschatca** Rchb. f. Fl. Germ. XIII. XIV 146 t. 478. — Yun nan. Ex silvis. Ta tsin teon. (Siméon Tén no. 1331!)

5. **Epipactis Mairei** Schlechter in Fedde, Repert. Beiheft 4 (1919) 55 et 148. — Yun nan. Pe yen tsin, in silvis. (Siméon Tén sine no.!).

6. **Epipactis setschuanica** Ames et Schlechter in Fedde, Repert. Beiheft 4 (1919) 56 et 149. — Yun nan. Pe tsao lin, in silvis. (Siméon Tén no. 1383!)

Die Blüten sind etwas kleiner als in der Diagnose angegeben und ihrer Farbe nach sind sie „flavi“, während die der Wilsonschen Exemplare „brownish“ sein sollen, sonst konnte ich keinen Unterschied finden.

7. **Epipactis discolor** Kränzl., spec. nov. — Radices copiosae, tenues, satis longae. Caulis ad 30 cm altus, tenuis, flaccidus, fractiflexus, basi cataphyllis ochreatis, brevi-acutatis, ringentibus vestitus, excepta inflorescentia ubique glaber. Folia subdisticha, infimum fere orbiculare, sequentia oblonga v. ovato-oblonga v. oblongo-lanceolata, apiculata v. acuta v. (suprema) acuminata, in bracteas decrescentia, margine et in venis subtus ciliolata, superne opaca, subtus pallidiora (unde nomen!), 2,5 ad 7 cm longa, 2 ad 3 cm lata. Inflorescentia racemosa, obscure secundiflora, vix 10 cm longa, utplurimum 10-flora, rhachis glandulis duriusculis obsita, scabra, bracteae lanceolatae, acuminatae, infimae 2 cm longae, flores duplo superantes, superiores multo minores, illis aequilongae, ovaria fere sessilia, minute scabriuscula. Sepala late ovata, acuta, dorso carinata, carinis minute serrulatis, ceterum glaberrima, 7 mm longa, basi 2 mm lata. Petala textura teneriore, ovata, acuta, non carinata, glabra, aequilonga et lata. Labelli hypochilium profunde naviculare, in fundo papillosum et carina mediana praeditum, epichilium subquadratum, antice retusum, basi callis 2 semiglobosis haud confluentibus praeditum, venis 3 percursum. Flores „rubri“. — Yun nan. Pe yen tsin (an recte?) in silvis. Flores Junio. (Siméon Ten sine no.!) — Adsunt specimina 4 satis bene exsiccata.

Die Pflanze ähnelt entfernt einem schwächlichen Exemplar unserer *Epipactis rubiginosa*, alle (4) Exemplare hatten das gleiche Aussehen. Von neuerdings publizierten chinesischen Arten ist zweifellos *Ep. yunnanensis* Schlechter die zunächststehende und es ist nicht absolut aus-

geschlossen, daß diese Art hier doch eines Tages in jene aufgehen wird, zunächst sind jedoch folgende, in der Schlechtersvhen Diagnose nicht erwähnte Abweichungen festzustellen: Erstens schlaffe, deutlich im Zickzack gebogene Stengel; zweitens die verschiedene Färbung der beiden Seiten der Blätter, drittens die Wimperung am Rande wie unterseits auf den Hauptnerven, Merkmale, die der Autor wohl erwähnt hätte, wenn sie bei *Ep. yunnanensis* vorkämen und die keineswegs für *Epipactis* selbstverständlich sind. Die Ähre ist armblütig und sehr undeutlich einseitwendig; die Blüten sind noch kleiner, nur 7 mm lang, die Sepalen haben auf dem Rücken einen kurz gezähnelten Kiel, sonst sind sie glatt, die Farbe ist dasselbe trübe Rotbraun wie bei unserer *Ep. rubiginosa.* Das Epichilium der Lippe hat am Grunde zwei sehr hervorragende Buckel, welche nicht miteinander verschmelzen, und drei ziemlich undeutliche Nerven; leider war dieser Teil bei allen Blüten nicht gut zu sehen, die Exemplare waren schon über ihre Höhe etwas hinaus. Schließlich blüht *Ep. discolor* im Juni und *Ep. yunnanensis* im August. Die anderen Schlechterschen Arten kommen nicht in Betracht. — Leider hat der Sammler nicht gesagt, ob die Blüten Vanillinduft haben, der unsere *Ep. rubiginosa* bekanntlich auszeichnet; auch beim *Ep. yunnannensis* scheint er zu fehlen.

8. **Orchis Chusua** D. Don Prodr. Fl. Nepal. (1823) 23. — Yun nan. Ex vertice montis Pe trao lin. (Siméon Tén no. 1377!)

9. **Orchis puberula** King et Pantl. in Ann. Roy. Bot. Gard. Calcutta VIII (1898) 304 t. 403. — Yun nan. Ta tsin teou. (Siméon Tén no. 1326! Fl. 28 Septembri.

Die Blüten sollen nach Angabe des Sammlers „paulo flavi" sein, wie er in seinem etwas wunderlichen Latein sagt, gemeint ist wohl „pallide flavi". King und Pantling sagen: the flowers are white", bilden sie aber ganz hellrosa ab mit einzelnen roten Punkten auf dem Labellum. Im übrigen stimmen Exemplare, Text und Abbiidung so gut wie nur möglich. — Die Art ist in der Schlechterschen Zusammenstellung noch nicht erwähnt.

10. **Anthogonium gracile** Wall. ex Lindl., Cat. no. 7398 ex Lindl., Gen. et Spec. Orch. (1840) 426, non Lindl. = *Anthogonium corydaloides* Schlechter in Fedde, Repert. Beihefte Bd. IV (1912) 66 et 230. Yun nan. Kon ty. (Siméon Tén no. 1302!) Exeunte Augusto.

Über die Autorschaft dieses Namens lauten die Lesarten verschieden, geht man bis auf die Quellen zurück, so findet man, daß Lindley stets Wallich als Autor nennt, so in dem Introduction to the Natural System 2. ed. (1835) 341, wo der Name zuerst vorkommt, wie in den Genera and Species und in Übereinstimmung hiermit steht auch im Index Kewensis Wallich als Autor der Gattung sowohl wie der Art. Bentham hat in den Genera Plant. III, 515 in striktem Widerspruch hierzu Lindley zum Autor gemacht und ihm ist Hooker in der Flora of Brit. India III, 823 gefolgt, selbstverständlich auch Grant, Orchids of Burmah S. 138 und schließlich Schlechter in seinem „Orchideologiae Sino-Japonicae Prodromus" S. 66, was alles zusammen nichts an der oben festgestellten Tatsache ändert,

daß Lindley die Autorschaft von vornherein abgelehnt hat. Die neu aufgestellte Art *A. corydaloides* Schlechter ist, soweit sich aus den besonders hervorgehobenen Merkmalen ergibt, nichts weiter als die Stammart. Schon Griffith, der die Pflanze in den Notulae III, 383 gut beschreibt, sagt geradezu: „flos fumarioideus purpureus. Der rechte Winkel, den das Ovarium mit dem Perigon bildet und der nach Schlechter eines der Merkmale seiner Art sein soll, findet sich auf Griffith's Abbildung in den Posthumous Papers III t. 345. Diese ist, wie die meisten Abbildungen jenes Werkes, roh in der Technik aber charakteristisch und um das andere „Merkmal" zu erwähnen — auf ein etwas tiefer geteiltes Labellum gleich eine neue Art aufzustellen, geht denn doch nicht an; das hieße, die Haarspalterei zum Prinzip erheben. Hooker war seinerzeit ganz im Recht, als er in Flora of Brit. India VI, 823. *A. Griffithii* Rchb. f. und die in Griffiths Werken beschriebene Art zu *A. gracile* Wall. zog und die *A. corydaloides* Schlechter ist gleichfalls nichts anderes. Das Verbreitungsgebiet reicht übrigens noch viel weiter, denn die Pflanze ist auch von Java bekannt (Lobb no. 349! in herb. Petropol.). Reichenbach hat in der Bonplandia II (1854) 90 (= Walp. Ann. VI, 471) ein *A. Griffithii* aufgestellt, zu dem er aber in den Annalen hinzufügt: „Monet ill. Lindley nil nisi ipsissimum *A. gracile* Wall.," eine Bemerkung, der er nicht widersprach.

11. **Cynosorchis gracilis** Kränzl., Orch. Gen. et Spec. I (1898) 488 et in Engl. Jahrb. XXXVI (1905), Beiblatt 82, 27. — *Amitostigma gracile* Schlechter in Fedde, Repert. Beiheft IV (1919) 93. — Yun nan. Pe ye tsi. Koan ie myao. (Siméon Tén no. 1178!)

Meinen Untersuchungen und dem, was ich nach nochmaliger Prüfung des Materials gesagt habe, habe ich nichts hinzuzufügen noch etwas zurückzunehmen. Sollte sich trotzdem an frischem Material nachweisen lassen, daß die Blüte eine ⌒ gestaltete Narbenfläche besitzt, so wäre damit ihre Zugehörigkeit zu *Gymnadenia* erwiesen, dann aber wäre es wohlgetan, alle Orchidaceen, die wir jetzt als echte *Cynosorchis*-Arten ansehen, auf eine derartige Narbenfläche hin noch einmal zu revidieren. Der leicht umgebogene Rand der Antherenkanäle findet sich ähnlich bei *Hemipilia*, es ist die Andeutung einer Bursicula, aber noch keine vollständige und derartig deplazierte Staminodien, wie sie nach Schlechter hier vorkommen sollen, wären ein Unikum; ich halte diese Organe für Narbenfortsätze. — Von den l. c. beigebrachten Zitaten ist eins falsch: *Gymnadenia tryphiaeformis* Rchb. f. Otia Hamburg (1878) 51; dort steht nämlich das gerade Gegenteil, denn diese Art ist von Reichenbach selbst zurückgenommen, publiziert ist sie in Journ. of Botany XIV (1876) 209. Die Stelle in den „Otia" lautet: „Haec omnia a viro ill. (Miquel) scripta . . . . me seduxerunt, ut eandem plantam (*G. gracilis* Miq.) sub nomine *G. tryphiaeformis* descripserim." Daraufhin durften „Otia" nicht zitiert werden, das richtige Zitat wäre in Engl. Jahrb. l. supra c. zu finden gewesen (abgesehen vom Ind. Kew.). Auf eine weitere Discussion über die Gattung *Amitostigma* Schlechter mich hier einzulassen, habe ich keine Veranlassung.

12. **Platanthera Susannae** Lindl., Gen. et Spec. Orch. (1835) 295.

Huc ma judice *Pecteilis Henryi* Schlechter in Fedde, Repert. Beiheft 4 (1919) 121. — Yun nan. Pe yen tsin. Ex silvis. (Siméon Tén no. 1326!)

Die mir vorliegenden Exemplare sind in Abmessungen und sonstigen Merkmalen ein genaues Mittel zwischen *Pl. Susannae* und der Pflanze, welche Dr. Schlechter jetzt *Pecteilis Henryi* genannt hat. Das am besten erhaltene hat außerdem ein bisher nirgend erwähntes Merkmal, die 13 cm langen Sporne sind genau von der Mitte an gegenläufig nach oben gebogen, so daß die Spitze nahe der Mündung liegt; auch sind bei demselben Exemplar die Unterschiede zwischen Laubblättern und Stengelscheiden nahezu verwischt und die Seitenzähne des Labellums kürzer als ich sie je beobachtet habe. Gleichwohl kann ich mich nicht entschließen, hierauf hin eine neue Art zu machen, so groß die Versuchung auch ist und von j her war, in *Pl. Susannae* eine Gruppe von Arten zu sehen, denn die anderen Exemplare von demselben Standort zeigen alle diese Merkmale abgeschwächt oder undeutlich. — Eine Zwischengattung als Brücke zwischen *Habenaria* Willd. und *Platanthera* L. C. Rich. ist nicht möglich. Ich stütze mich hierbei auf die Ansicht Sir Joseph Hookers, der sich mit mir lange über diese Frage (gelegentlich meiner Dissertationsschrift über *Habenaria*) unterhalten hat. Auf Grund der Untersuchung zahlreicher indischer Arten müsse er die Wichtigkeit der Antherenkanäle ablehnen, da sie in allen Graden vorkommen vom völligen Fehlen bis zur vollständigen Ähnlichkeit mit denen von *Habenaria*. Die Narbenfortsätze wolle er gelten lassen, es fänden sich aber nicht selten zwei buckel- oder brustähnliche Vorwölbungen auf der Narbenfläche, die ebenfalls von ganz schwachen Anfängen bis zu stark entwickelten Protuberanzen variierten, doch gab er schließlich allerdings zu, daß Narbenfortsätze und Narbenflächen zwei recht wesentlich verschiedene Dinge seien. Es handelt sich also um Merkmale, die man von jeher kannte und wenn Finet daraufhin seine Gattung *Hemihabenaria* aufstellte, die sich nicht durchzusetzen vermochte, so gilt genau dasselbe von der ganz einseitig auf *Pl. Susannae* und nur auf diese zugeschnittenen alten Rafinesqueschen Gattung *Pecteilis*.

13. **Platanthera praeustipetala** Kränzl., spec. nov. — Tuberidia ellipsoidea, 1.5 ad 3 cm longa, 6 ad 7 mm crassa. Caulis cum spica 25 ad 30 cm altus, basi tantum foliatus. Folia 2 v. 3 anguste linearia, acuminata, utplurimum 10 cm longa, 1,5 ad 2 mm lata, folium 1 multo minus in scapo. Spica plerumque 10 interdum 12 cm longa (tortilis ?), secundiflora, floribus 15 ad 18, bracteae lanceolatae, acuminatae, 4 mm longae, ovarium curvulum, brevi-rostratum, 5 mm longum. Sepala ovato-oblonga, obtusa, concava, dorsale modice carinatum, omnia 3 mm longa, basi vix 1 mm lata, textura tenera. Petala sublongiora, e basi late ovata subito in acumen lineare, crassiusculum v. subcartilagineum, quasi praeustum contracta, 4,25 mm longa, basi 1,5 mm lata ibique trinervia. Labellum in quarta basilari integrum, subquadratum, deinde tripartitum, lobi lineares, laterales quam intermedius paulo breviores et angustiores, 3 mm longi, intermedius 3,5 mm longus, calcar dimidium usque filiforme, deinde leviter inflatum, obtusum, 4 mm longum. Gynostemium latum quam altum, glandulae

conspicuae, massulae grosse granulatae. Flores pallide flavi. — Fl. exeunte Septembri. — Yun nan. Pe tsao lin. Ex silvis. (Siméon Tén no. 1384!)

Im ganzen Aufbau erinnert die Pflanze mehr an manche *Peristylus*-Arten, eine Verwandtschaft, an die man angesichts des Spornes und besonders der Säule nicht denken darf. Auch gewisse *Herminium*-Arten könnte man zum Vergleich heranziehen. Die Blüten stehen alle nach einer Seite und erinnern sehr an *Herminium*, soweit nur das Äußere in Betracht kommt. Das Labellum hat an der Basis einen flach ausgehöhlten quadratischen Teil, an den sich die drei wenig verschiedenen Lappen ansetzen, der Sporn ist annähernd so lang als die Lippe. Sehr apart sind die Petalen, welche aus breiter Basis ziemlich rasch in eine sehr viel schmalere, dunklere, etwas knorpelige Spitze verschmälert sind; auch dies kommt, wenn auch selten, bei *Herminium* vor. Von diesem Merkmal habe ich den Speziesnamen entlehnt. Die Blätter, zwei ziemlich tief unten stehende und ein höher stehendes, kleineres, würden nahebei den Ausdruck „filiformia" rechtfertigen, sie sind indessen etwas zu flach.

14. **Platanthera Henryi** (Rolfe) Kränzl., Orch. Gen. et Spec. I (1899) 632 = *Pl. Henryi* Rolfe in Journ. Linn. Soc. XXXVI (1903) 55 et R. Schlechter in Fedde, Repert., Beihefte Bd. 4 (1919) 111. — *Habenaria Henryi* Rolfe in Kew Bull. (1896) 202.

Herr R. A. Rolfe hat übersehen, daß ich bereits die Umtaufung seiner *Habenaria Henryi* hatte vornehmen müssen und Schlechter ist ihm darin gefolgt.

15. **Platanthera minor** Rolfe in Bot. Ztg. (1878) 75. — Yun nan. Pe tsao lin. (Siméon Tén no. 1390!)

16. **Platanthera ? Bakeriana** Kränzl., Orch. Gen. et Sp. (1898) 633. — Yun nan. Ta tsien teon. (Siméon Tén no. 1334!)

Das einzige vorhandene Exemplar hatte nur beschädigte Blüten, ich habe mich genötigt gesehen, wesentlich nach dem Habitus zu bestimmen und das ist gerade in dieser Gruppe von *Platanthera* ziemlich nichtssagend.

17. **Platanthera obcordata** Lindl. in Wall. Cat. (1828) et Gen. et Sp. Orch. (1835) 290. — Yun nan. Siao tsin ho. (Siméon Tén no. 1213!)

Von dem sehr abweichenden Habitus abgesehen ist die Pflanze eine typische *Platanthera*, besonders was die Struktur der Säule angeht. Ein zwingender Grund, gerade hier eine neue Gattung (*Phyllomphax* Schlechter) mit den dadurch unvermeidlichen Umtaufungen aufzustellen, liegt keinenfalls vor.

Platanthera Florenti Franch. et Sav., Enum. pl. Jap. II (1879) 32. — Als ich 1897 an dem I. Bd. meiner Orchid. gen. et spec. schrieb, habe ich, wenn schon mit großem Bedenken und ? diese Art als Synonym zu *Pl. minor* Rchb. f. gestellt. Material hatte ich nicht zur Hand und den von Franchet angewendeten Vergleich mit *Pl. bifolia* L. C. Rich. nahm ich leider ernster, als er es verdient. Die Pflanze ist inzwischen nochmals als *Pl. listeroides* Takeda in Tokio Bot. Mag. XXIV (1910) 109 beschrieben worden und es ist sehr schade, daß dieser außerordentlich gut geprägt. Name nicht beibehalten werden kann. Die Pflanze hat zwei fast gegen-

ständige basale Blätter und ist den Blüten nach eine *Platanthera*, damit ist die Ähnlichkeit zu Ende, im übrigen ist sie von den Blättern angefangen bis zu den Einzelheiten der Blüten völlig verschieden von unserer europäischen *Pl. bifolia*, während sie in der Tat an *Listera ovata* erinnert. — Ich nehme also die von mir 1897 geschriebene (1899 publizierte) Zusammenziehung mit *Pl. minor* Rchb. f. zurück.

18. **Habenaria Delavayi** Finet in Rev. Gen. Bot. XIII (1901) 527. — Yun nan. Te yen tsin. (Siméon Tén no. 1216!)

19. **Habenaria glaucifolia** Bureau et Franchet in Journ. de Botan. V (1891) 152. — Yun nan. Ni thon. (Siméon Tén no. 1422! 1425!)

20. **Habenaria diceras** Schlechter in Notes Roy. Bot. Gard. Edinb. XXIV (1912) 101 t. 78. — Yun nan. Ni thon pr. Pe tsao lin. (Siméon Tén no. 1381!)

21. **Habenaria Miersiana** Champ. in Hook. Kew Journ. Bot. VII (1855) 37. — Yun nan. Pe yen tsin. (Siméon Tén sine no.!)

22. **Habenaria lacertifera** Benth., Fl. Hongkong. (1872) 362. — Hong kong. Happy valley. (Feilberg sine no.!)

23. **Habenaria atramentaria** Kränzl., spec. nov. — (*Peristyloideae.*) Tuberidia globosa, 1,5 cm diametro. Caulis gracilis, strictus, leviter flexuosus, cum spica 30 ad 36 cm altus, basi foliatus. Folia 3 v. 4 pro caule parva, lanceolata, acuminata, 4 ad 5 cm longa, 1 ad 1,2 cm lata, 2 ad 3 cm inter se distantia, additis foliolis ad 5 parvis, bracteiformibus, acuminatissimis, spica ad 13 cm longa, $1/3$ totius plantae occupans, multiflora, cylindracea, laxi- aut densiflora, bracteae lanceolatae, acuminatae, inferiores flores, superiores ovaria aequantes, 1,2 ad 8 mm longae, ovaria non rostrata, ad 8 mm longa. Sepala oblonga, obtusa, concava, carinata, lateralia cum apiculo vix prominulo ante apicem ipsum, 3,5 mm longa. Petala sublatiora, aequalia, oblonga, obtusa, non apiculata. Labellum e basi integra mox in lobos 3 lineares divisum, quorum laterales fere filiformes cum intermedio breviore latiore triangulo, obtuso cruciati, subreflexi, omnes apice ipso obtusi, intermedius 3 mm longus, laterales 3,5 ad 4 mm longi, calcar filiforme, 5 mm longum apicem versus leviter incrassatum, acutum. Gynostemium, minimum in fundo calcaris subabsconditum, apices processuum stigmaticorum nitiduli, vix (sub lente valida) conspicui, antherae canales nulli. Tota planta sicca (more *Brachycorythidis*) nigra. Flores pallide (paulo) flavi. — Fl. Septembri. — Yun nan. Pe yen tsin. (Siméon Tén no. 1261!)

Wenn ein Bastard zwischen einer *Habenaria* und einer *Brachycorythis* zumal in China überhaupt möglich wäre, so müßte er habituell so ausfallen, wie die hier beschriebene Art. Und zu diesem Gesamtbild stimmt auch ganz gut das außergewöhnlich winzige Gynostemium, dessen Narbenfortsätze, oder richtiger deren Spitzen nur mit Zuhilfenahme der 30fachen Vergrößerung zu finden sind. Nach den rein technischen Einzelheiten gehört die Pflanze in eine leider schon sowieso an Mikrospezies reichen Gruppe der *Habenaria acuifera*, *Hancockii* und ähnlicher. Nicht häufig ist wenigstens in diesem Formenkreise das Auftreten eines winzigen Kiels

und einer minimalen Spitze auf den seitlichen Sepalen, des ferneren sind die drei Abschnitte des Labellums und ihre Längenverhältnisse etwas abweichend von denen der verwandten Arten. — Alles in allem eine unerfreuliche Art, die nicht aufstellen zu müssen ich viel vergebliche Mühe aufgewendet habe.

24. **Habenaria peyentsinensis** Kränzl., spec. nov. — (*Plantagineae.*) Tuberidia ellipsoidea v. ovalia, 1,5 cm longa, villosa. Caulis cum floribus 12 ad 18 cm altus, strictus. Folia plerumque 3, dissita, latissime ovata, infimum fere orbiculare, sequentia paulo angustiora, omnia apiculata, albido-marginata, 2 ad 5 cm longa, 2 ad 3 cm lata, vagina in scapo 1 acuminata, 3 cm longa. Spica pauci- et laxiflora (5- ad 8-flora), bracteae lanceolatae, pedicellum cum ovario aequantes, 1,5 ad 2 cm longae, supremae breviores. Sepalum dorsale ovatum, acutum, cucullatum, 8 mm longum, basi (expansum) fere aequilatum, sepala lateralia deflexa, ovata, acuta, obliqua v. asymmetrica, 1 cm longa, 5,5 mm lata. Petala simplicia, erecta, cum sepalo dorsali non conglutinata, linearia, subfalcata, 6 mm longa, vix 1 mm lata. Labelli lobi laterales rhombei, margine exteriore minute denticulati, lobus intermedius linearis, e basi paulo latiore sensim angustatus, apice subito acutatus, totum labellum basi cuneatum, 1 cm longum et inter lobos laterales latum, calcar leviter curvatum clavatum, apicem versus leviter inflatum, obtusum, 1,8 ad 2 cm longum. Anthera crassa, 3,5 mm alta, canales antherae 2,5 mm longae, recurvae, processus stigmatici crassiusculi, recti, aequilongi, staminodia pro flore magna, triangula, crasse papillosa. — Flores albi. — Fl. ineunte Septembri. — Yun nan. Pe yen tsin. (Siméon Tén no. 1352!)

Ein Exemplar dieser Pflanze mit abgebrochenem Blütenstand würde jeder für *Platanthera viridis* Lindl. halten, so sehr gleich sind die Blätter und der ganze Habitus. Zieht man die Merkmale alle in Betracht, so erhält man ein Bild, das an *Hab. Richardiana* R. Wight gemahnt, aber bei dieser Art stehen 4 bis 6 sehr spitze Blätter ziemlich dicht am Grunde des Stengels; die übrigen Teile, besonders die Blätter der Blüte stimmen so ziemlich. Weder diese Art noch eine der Verwandten hat Staminodien von dieser Größe und dieser runzligen rauhen Oberfläche. Es ist somit zunächst sicher, daß *Hab. Richardiana* nicht vorliegt und eine ins einzelne gehende Untersuchung fördert noch mehr Unterschiede zutage. Unter den Habenarien von Schlechters Prodom. Orchid. Sino-Japonicae ist keine die gut mit diesen Merkmalen hier übereinstimmt.

25. **Habenaria bihamata** Kränzl., spec. nov. — (*Diphyllae.*) Tuberidia mihi non visa. Folia 2 humistrata, suborbicularia, brevi-apiculata v. subrhombea, 2,5 cm longa et lata (in uno specimine 5 cm longa lataque). Scapus tenuis 20 ad 25 cm (48 cm) altus, brevissime pilosus, foliolis bracteiformibus paucis valde dissitis praeditus, spica 7 (17?) cm longa, obscure distichantha, pluri- ad multiflora, laxiflora, bracteae lanceolatae, acuminatae, 3 ad 4 mm longae, ovarium cum rostro 7 mm longum. Sepalum dorsale ovatum, obtuse acutatum, 4 mm longum, basi 2,5 mm latum, lateralia triangula, subfalcata, acuminata, 4,5 mm longa,

energice in ovarium reflexa. Petala cum sepalo dorsali arctissime conglutinata, illique aequilonga, triangula, acuminata, in dimidio postico membranacea. Labelli basin usque partiti partitiones laterales filiformes, arctissime reflexae, apice cornuum instar recurvatae, 4 mm longae, partitio intermedia linearis, arctissime, deflexa latior quam laterales, apice obtusa, 5 ad 6 mm longa. calcar stricte dependens per duas tertias filiforme. deinde inflatum. apice obtusum. 6 mm longum, lobo intermedio labelli parallelum et aequilongum, canales antherarum semierecti. processus stigmatici longiores. deflexi, antice incrassati, leviter bipartiti. Flores rubri. — Fl. Julio. — Yun nan. Pe yen tsin. (Siméon Tén sine no.!)

Eine typische Art der Sektion *Diphyllae* und sehr nahe verwandt mit *Hab. diceras* Schlechter. Auffällig ist zunächst die rote Farbe der Blüten. Der Sammler, dessen Latinität etwas angealtert zu sein scheint. sagt aber ausdrücklich „Fl. rubus"! Die in ( ) gesetzten Maße beziehen sich auf ein wesentlich größeres Exemplar. welches bei den anderen lag. aber leider von der Fäulnis derart mitgenommen war. daß eine Untersuchung der Blüten zu nichts geführt hätte: soweit es sich ohne die Blüten aufzukochen ersehen ließ, glichen sie denen der drei kleineren Exemplare. Den Abmessungen der Sepalen und Petalen nach könnte man an *Hab. diplonema* Schlechter denken. aber dem widersprechen die Ausmaße des Labellums. welche völlig verschieden sind. Ferner stimmen die der Säule durchaus nicht. Trotz aller Abweichungen doch eine sehr ähnliche Art. Die Abbildung von *Hab. diceras* in den Notes R. B. G. Edinb., plate LXXVIII. zeigt einen sehr viel dichteren Blütenstand. die von *Hab. diplonema* eine viel schwächere Pflanze; viel anzufangen ist mit beiden Abbildungen nicht.

26. **Habenaria Simeonis** Kränzl., spec. nov. — (*Chlorinae* — olim 1898.) Tuberidia ellipsoidea. interdum subcylindracea. 2.5 ad 4 cm longa. 1 ad 1.5 cm crassa. Caulis cum inflorescentia 20 ad 30 cm altus. strictus v. leviter flexuosus. Folia in tertia inferiore caulis plerumque 3. longe vaginantia. compressa. oblonga v. oblongo-lanceolata. acuminata. in vaginas caulis illaeque in bracteas decrescentia. basilaria saepius recurvata. ad 6 cm longa, ad 2 cm lata, vaginae caulis 3 acuminatissimae. spica subcylindracea interdum capitata, pluri- ad multiflora. 4 ad 7 cm longa. 3 cm diametro. bracteae florum anguste lanceolatae. longissime acuminatae. carinatae. margine et antice in dorso fimbriatae. 1.5 ad 1 cm longae. Pedicelli cum ovariis 1.5 cm longi. ovaria rostrata. Sepala petalaque forma et magnitudine vix diversa. late oblonga v. ellipsoidea. antice rotundata, sepala lateralia semideflexa. paulo tantum majora subobliqua, dorsale cucullatum, illud et petala 5 mm. lateralia 6 mm longa. sep. dors. et petala 3 mm lata, lateralia 3.5 mm. Labellum trilobum. basi ipsa simplice, lobi laterales parvi, lineares, paulum infra basin oblique inserti, 2,5 mm longi, lobus intermedius 8.5 (totum labellum 9 mm) longus. duplo latior quam laterales, calcar filiforme a dimidio apicem versus vix incrassatum, 2,8 ad 3 cm longum: Gynostemium valde reclinatum. processus stigmatici arcte deflexi, crassiusculi canales antherarum elongati

protensi, recti, rostellum breve, triangulum, pronum. Flores flavi. — Fl. exeunte Augusto. — Yun nan. Pe yen tsin. (Siméon Tén no. 1255!)

Eine wenn auch nur sehr unbestimmte Ähnlichkeit mit dieser Art hier zeigt die Abbildung von *Hab. viridiflora* R. Br. in R. Wight's Icon. pl. Ind. or. V, t. 1705. Ich betone nochmals, daß nur der allgemeine Eindruck mit diesem Vergleich wiedergegeben werden soll, bei der genaueren Untersuchung verflüchtigt sich alle und jede Übereinstimmung. Diese Art ist schwer zu deuten und daß alle von Hooker in Fl. Brit. Ind. VI, 150 hierzu einbezogenen Arten wirklich zu ihr gehören, ist mir sehr zweifelhaft; so z. B. die von Griffith in Notulae III, 269 beschriebene und in den Icon. Pl. Asiat. III, t. 342 abgebildete Pflanze. Ohne sehr reiches Material ist diese Frage nicht zu lösen; Reichenbach, der die Orchideen aus Rob. Browns Prodromus bekanntlich zum Gegenstand einer besonderen Studie gemacht hat, hat gerade diese Frage nicht berührt. Nun fehlt freilich in den beiden bisherigen Aufzählungen chinesischer Orchidaceen, der von R. A. Rolfe und der von Schlechter, *Hab. viridiflora* R. Br., was aber nicht viel besagen will, denn auf Vollständigkeit machen diese Arbeiten keinen Anspruch. Mag nun *Hab. viridiflora* R. Br. eine Art sein, oder, was mir das wahrscheinlichere scheint, ein Knäuel von Arten, so mußte ich bei dieser neu aufgestellten mich mit der Stammart auseinandersetzen, in deren Nähe sie im System gehört.

Herr Dr. Schlechter übt an der von mir aufgestellten Gruppe der „*Chlorinae*" eine etwas abfällige Kritik. Daß diese Gruppe viel zu wünschen übrig läßt, wußte ich bereits vor zirka 25 Jahren und habe es klar und deutlich auf S. 397 meiner damaligen Bearbeitung der Orchidaceen gesagt. Die Sache ist also nicht gerade neu. — Daß ich mit dem Material von heute und dem, was ich mittlerweile gelernt habe, jetzt vieles anders sagen würde, mag Herr Schlechter mir glauben oder auch nicht — nihil curo. Wenn ich somit für die Kritik die Priorität für mich in Anspruch nehmen darf, so überlasse ich ihm um so bereitwilliger die der an dieser und anderen Stellen von ihm beliebten Form und Ausdrucksweise, denn die ist in der Tat neu.

27. **Habenaria crassilabia** Kränzl. spec. nov. — *Peristyloideae-Tradescantifoliae*.) Tuberidia ellipsoidea, ultra 3 cm longa, 1,2 cm crassa. Cataphylla mox grandescentia, infrafoliacea 3 v. 4, ochreata, ample vaginantia, folia 4 (v. interdum plura?) fere basilaria, oblonga, acuta, approximata, membranacea, satis tenera, 5 ad 8 cm longa, 1,8 ad 3,2 cm lata, plurinervia. Scapus cum inflorescentia 30 ad 36 cm longus, foliolis bracteiformibus 4 longe acuminatis praeditus, spica multi-satis laxiflora, ad 15 cm longa, dimium fere totius plantae efficiens, bracteae longe acuminatae; ovato-lanceolatae, 1,3 ad 1 cm (supremae) longae, ovaria brevirostrata aequantes. Sepala ovata, acuta, tenui-membranacea, 4 mm longa, basi 3 mm lata. Petala late ovata, obtusa v. retusa, fere subbilobula, sepalis aequilonga, crassiora quam sepala. Labellum basin usque tripartitum, lobi laterales ovati, falcati, acuti, lobus intermedius ligulatus, obtusus, totum labellum textura firma, satis crassa, partitiones omnes

inter se et sepalis petalisque aequilongae, calcar e basi filiformi ampliatum, paulum incrassatum, acutum, incurvum, 6 mm longum. Gynostemium breve, anthera pro rata parva, canales breves, rostellum amplum, processus stigmatici quam canales longiores. Flores pallide flavi. — Fl. exeunte Augusto. — Yun nan. In silvis pr. Pa yen tsin. (Siméon Tén no. 1333!)

Soweit die Frage ohne Vergleichsmaterial klarzustellen ist, wird man *Hab. Hancockii* Rolfe als die nächstverwandte Art ansehen müssen, sie hat allerdings auch Anklänge an die mehr östliche *Hab. tradescantifolia* Rchb. f. von den Fidji-Inseln, deren sie noch mehr ähneln würde, wenn die Blätter etwas höher am Stamm hinaufgerückt wären.

28. **Peristylus goodyeroides** Lindl., Gen. et Sp. Orch. (1835) 299. — Yun nan. Pe yen tsin. (Siméon Tén no. 1217! 1218!)

29. **Satyrium nepalense** Don., Prodr. Fl. Nepal. 26 (1802—03!. — Yun nan. Ni thon. (Siméon Tén no. 1421!)

var. **Wightiana** Hook. f. in Fl. Brit. Ind. VI (1894) 168. — Yun nan. Pe tsen lin. (Siméon Tén no. 1416!)

30. **Satyrium microcephalum** Kränzl., spec. nov. — Tuberidia oblonga v. ovata, ad 3 cm longa, villosa. Caulis cum spica 15 ad 22 cm altus, cataphylla infrafoliacea 2, laxe vaginantia, supra retusa. Folium unicum, ovatum v. oblongum, obtuse acutatum v. obtusum, brevi-vaginatum, lamina 2 ad 5 cm longa, 1,8 ad 2,5 cm lata, foliola in scapo 1 v. 2, lanceolata, acuta, spica brevis, subcapitata, pauci- (6- ad 8-) flora, 2 ad 2.5 cm longa, 1,5 ad 2 cm diametro, bracteae infimae reflexae, ovatae, acuminatae, 9 mm longae, supremae erectae, minores, ovarium brevi-rostratum, pro flore crassiusculum, 4 ad 5 mm longum, 2 mm crassum. Sepala petalaque paulo minora oblonga, concava, obtusa, basin usque libera, 3 mm longa, vix 1,2 cm lata, omnia margine nusquam, extus tantum sub lente valida minute papillosa. Labellum subglobosum, profunde cucullatum, extus carinatum, apice paulum erosulum, haud explanandum, 4 mm longum et basi latum, calcaria filiformia v. leviter curvata, ovarium subaequantia. Gynostemii stigma quadratum, rostellum trilobum, lobus intermedius major, dilatatus, laterales multo minoses. Flores flavi. — Fl. exeunte Septembri. — Yun nan. In silvis Ni thon. (Siméon Tén no. 1397!)

Eine zierliche, kleine Pflanze, welche als neu zu erkennen leicht genug war. Außer dem Habitus ist an der Pflanze sonst beinahe nichts von besonderem Interesse zu bemerken, dieser ist allerdings auffallend genug und auch bei dieser Art völlig abweichend von dem Typus des *S. nepalense* Don, den die sämtlichen bisher aus China bekannten *Satyrium*-Arten mehr oder minder stark variieren. Bemerkenswert ist auch der Standort „in silvis". Ich hatte 5 Exemplare zur Verfügung, welche abgesehen von ihrer wenig verschiedenen Größe alle einander glichen.

31. **Hemipilia flabellata** Bur. et Franch. in Journ. de Botan. V (1891) 152. — Yun nan. Pe yen tsin, in silvis. (Siméon Tén sine no.!)

Als Abweichungen von der Originaldiagnose wäre zu vermerken: 1. Der Schaft hat nicht mehrere sondern nur ein einziges deckblattähn-

liches Blättchen. 2. Das Labellum ist in Umriß fünfeckig mit vorn ausgerandeter Vorderseite. 3. Jede Spur von Zähnelung des vorderen Randes fehlt. Alle anderen Merkmale stimmen vortrefflich, vor allen Dingen ist „flabellatum" die einzig mögliche Bezeichnung für das Labellum, welches auch (wie sonst die ganze Pflanze) in ihren Abmessungen gut stimmt, Ich wage nicht, auf diese Abweichungen hin eine nov. spec. zu machen. Wie enorm die Anzahl der Orchideen anschwillt, davon ist *Hemipilia* ein Beispiel, Schlechter zählt 11 gut unterscheidbare Arten auf und man kann bereits die Unterabteilung der *Cordifoliae* von den anderen abtrennen und *H. cordifolia* Lindl. war lange Zeit die einzige bekannte Art. Bentham kannte zu Anfang der achtziger Jahre nur 2 Arten.

32. **Hemipilia silvatica** Kränzl., spec. nov. — Tuberidia ellipsoidea, interdum stipitata, ad 2 cm longa, cataphyllum 1 acutum sub folio late ovato-acuto, 1,5 ad 3 cm longo, $^3/_4$ ad 2 cm lato. Scapus tenuis, omnino nudus cum spica 4 ad 12 cm altus, tenuis, spica secundiflora, 2- ad 12-flora, floribus haud resupinatis, bracteae lanceolatae, acuminatae, ovaria subsemiaequantes, 6 mm longae, ovaria rostrata, 9 ad 10 mm longa. Sepala oblonga, obtusa, dorsale concavum, vix 3 mm longum, lateralia erecta, paulo ultra 3 mm longa. Petala elliptica, apice rotundata, tenerrima, 2 mm longa, 1 mm lata. Labelli lobi laterales parvi, oblique divergentes, apice rotundati, apiculati, lobus intermedius e basi cuneata obtriangulus, antice retusus, medio apiculatus, totum labellum 5 mm longum, lobus intermedius antice 3 mm latus, lobi laterales 2 mm longi, calcar pro flore amplum, obtusum, 3 mm longum, sepalis aequilongum. Gynostemium breve, globosum, rostellum lineare, antheram non aequans. Flores albi. — Fl. exeunte Septembri. — Yun nan. Ni thon, prope Pe tsoo lin. (Siméon Tén no. 1396!)

Eine kleine, sehr zierliche Art, die wohl *H. cruciata* Finet zunächst steht, aber keinenfalls identisch ist. Die Exemplare variieren sehr an Größe, die kleinsten hatten nur 4—5 cm Höhe, mit 2 Blüten, die größten 12—13 cm Höhe mit ungefähr 12 Blüten. Diese kleinsten ähneln im Habitus ungemein gewissen winzigen *Platanthera*-Arten des japanisch-chinesischen Gebietes.

33. **Herminium Ténianum** Kränzl., spec. nov. — Tuberidia globosa 1,5 ad 2 cm diametro, cataphyllum 1 infrafoliaceum, laxe vaginans acutum. Folium 1 oblongum v. oblongo-lanceolatum, acutum, 4 ad 10 cm longum, 1,5 ad 2 cm latum, addito foliolo 1 minore acuto medio in scapo, totus caulis cum spica 18 ad 24 cm altus, spica densiuscula, multiflora, 8 ad 10 cm longa, bracteae lanceolatae, acuminatae, ad 5 mm longae, ovaria superantes. Sepalum dorsale late oblongum, obtusum, 3 mm longum, 2 mm latum, lateralia similia, minora, subaequilonga, vix 2 mm lata, obtusa. Petala latissime ovata v. potius rhombea dicenda, obtuse acutata apice subcartilaginea, 2 mm longa et basi lata. Labellum maxima pro parte simplex, antice in lobulos 3 (quorum intermedius vix longior) aequales, obtusos divisum, callus nasiformis, subclavatus, proclivis, apice obtu-

sissimus, dense minuteque papillosus in medio disco, totum labellum 2,5 mm longum et latum. Gynostemium latissimum. Flores pallide flavi. — Fl. exeunte Septembri. — Yun nan. Pe tsao lin in silvis. (Siméon Tén no. 1387!)

Diese Art ist die zweite oder möglicherweise die dritte einer Gruppe von *Herminium*, welche auf der Lippe mit einem hornartigen Callus versehen sind. Dr. Schlechter zieht in seinem Orchid. Sino-Japon. Prodromus unter dem Namen *H. coeloceras* (Finet) Schlechter das von mir 1903 aufgestellte *H. unicorne* mit *Peristylus coeloceras* Finet (1901) zuammen. Diese Zusammenziehung kann berechtigt sein, es spricht aber doch manches dagegen. Zunächst bedeutet coeloceras „Hohlhorn". Wenn in meinen *H. unicorne* die Protuberanz der Lippe hohl gewesen wäre, hätte ich dies bemerkt und es in meine Diagnose aufgenommen; ich habe die Pflanze augenblicklich nicht zur Hand, entsinne mich ihrer aber noch ganz genau. Hiermit ist nichts gegen die von Schlechter eingeführte nov. comb. gesagt, aber die Zugehörigkeit meiner *H. unicorne* möchte ich zunächst wenigstens bezweifeln. Die Beschreibung dieser Art hier zeigt Punkt für Punkt Abweichungen von der von *H. unicorne*, angefangen von den Blättern bis zur Lippe, deren Protuberanz wie eine warzige Nase aussieht.

34. **Herminium angustifolium** Benth. ex Hook. f. Fl. Brit. Ind. VI (1890) 129. — Yun nan Pan y tien (Pe yen tsin). (Siméon Tén no. 1174! 1221!)

35. **Herminium Limprichtii** Schlechter in Fedde, Repert. Beiheft 4 (1919) 42 et 101. — Yun nan. Ta tsin tao. (Siméon Tén no. 1324! 1325!)

36. **Coelogyne elegantula** Kränzl., spec. nov. — Planta terrestris, radicibus villosis obsita. Pseudobulbi subglobosi, magnitudine nucis *Avellanae*, mox in caulem 4 ad 5 cm longum, tenuem, cylindraceum attenuati, cataphyllis paucis arctissime vaginantibus obsiti, bi- v. trifoliati. Folia angustissima, linearia v. lineari-lanceolata, acuminatissima, ad 15 cm longa, 5 ad 6 mm lata, scapus 12 ad 15 cm longus, apice pauciflorus, nudus, flores 1 ad 4 (interdum forsan plures ?), bracteae sub anthesi nullae, cicatrices tantum vidi, pedicelli cum ovariis 1,5 cm longi. Sepala petalaque vix minora oblongo-lanceolata, acuta, 2,2 v. 2 cm longa, 4 mm lata, dorsale et petala, conniventia, sepala lateralia subdeflexa. Labelli lobi laterales semiobovati, obtusi, lobus intermedius cuneatim dilatatus, antice profunde bilobus, utrinque obtusus, carinae inter lobos laterales 4 elevatae, margine ciliatae, in lobum intermedium decurrentes, totum labellum 1,8 cm longum, inter lobos laterales circ. 1 cm latum, lobi laterales 1,2 cm longi, intermedius 5 ad 6 mm longus, antice 5 mm latus. Gynostemium satis curvatum 1,1 cm longum. Flores „rubri" sec. collectorem. — Fl. Octobri. — Yun nan. Pan y tien (an reote ?). (Siméon Tén no. 1186!)

Im ganzen erinnert die Pflanze trotz des nicht gewimperten Labellums an *C. fimbriata* Lindl. Die Scheinknollen sind auffallend klein, nahezu kugelig und endigen in einen langen Halsteil, der dann 2 oder 3 auffallend

lange, schmale Blätter und einen gleichfalls schlanken Blütenschaft trägt. Die Blüten haben schon vor der Blütezeit keine Deckblätter mehr, ihrem Bau nach sind es typische *Coelogyne*-Blüten, wie sie sehr oft vorkommen, aber sie sind „rot" und das ist bei dieser Gattung außerordentlich auffallend. Die Farbe der getrockneten Blüten widerspricht der Notiz des Sammlers nicht, rote, besonders rosafarbige nehmen stets den Farbenton an, den die — leider spärlichen — Blüten zeigten.

37. **Arundina chinensis** Bl., Bijdr. (1825) 402. — Yun nan. Pe yen tsin. (Siméon Tén no. 1351!)

38. **Spathoglottis Fortunei** Lindl. in Bot. Reg. XXXI (1845) t. 19. — Yun nan. Pan y tien. (Siméon Tén no. 1249!)

39. **Dendrobium nobile** Lindl., Gen. et Sp. Orch. (1830) 79. — Yun nan. Pe yen tsin. (Siméon Tén sine no.!) Nomen vern. Che fou.

40. **Liparis bootanensis** Griff., Not. III (1851) 278, Ic. Pl. Asiat. III t. 287. — Yun nan. Pe yen tsin. in silvis. (Siméon Tén sine no.!)

Die Abbildung in King und Pantling, Orch. Sikk. Himal. I, 30 t. 40 stimmt bis auf Kleinigkeiten im Habitus und gänzlich in den Blüten. *L. oxyphylla* Schlechter in Fedde, Rep. Beiheft 4, 63 hat zweiblätterige Stämme und der Blütenstand ist kürzer als die Blätter, außerdem sind die Blüten größer, sonst scheint sie ähnlich zu sein. — In demselben Umschlagbogen lag noch eine ganz andere Art von *Liparis*.

41. **Liparis Téniana** Kränzl., spec. nov. — Pseudobulbi ovoidei ad 3 cm longi, basi 1 ad 1,5 cm crassi, cataphyllis quibusdam emarcidis tunicali. Folia 2 rarius 3, additis foliolis 1 v. 2 in ima basi caulis, oblongo-lanceolata, acuta, membranacea, trinervia, 6 ad 12 cm longa, 1,5 ad 2,5 cm lata, cauli adpressa, dimidium caulis cum inflorescentia 20 ad 36 cm alti subaequantia, scapus ceterum nudus, spica 6 ad 12 cm longa, pauci- ad pluriflora, sparsiflora (flores 8—15), bracteae lanceolatae, acuminatae, 3 ad 5 mm longae, pedicelli cum ovariis 1 cm longi. Sepalum dorsale late lineare, obtusum, lateralia late oblonga, subobliqua, obtusa, petala linearia, obtusa, omnia 8 mm longa, sepala lateralia 2,5 mm lata. Labellum cuneato-obcordatum, antice utrinque minute obtuseque denticulatum, a dimidio deflexum, basi complicatum, ad insertionem callis 2 acutis, subulatis praeditum, totum labellum vi expansum 8 mm longum, antice 5 ad 6 mm latum. Gynostemium generis. Flores „valde violacei" sec. collectorem. — Fl. Augusto. — Yun nan. Siao tsin ho. (Siméon Tén no. 1219!)

Eine Art, deren Aufstellung mir schwere Bedenken macht. Sie gehört zu den „*Bituberculata*", womit sehr wenig gesagt ist und violette Blüten sind auch kein sehr gutes Merkmal, aber die beiden verhältnismäßig kurzen, dem Stengel angedrückten Blätter von sehr dünnhäutiger Textur geben mit allem anderen zusammen doch ein besonders Bild ab. Ich hatte im ganzen 5 Exemplare von gleicher Entwicklung und nur in der Größe verschieden zur Verfügung.

15.

Scrophulariaceae.

By

Fr. J. Mathiesen.

1921.

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Preface.

In the present paper, partly on the basis of notes on the subject found in previous publications, and partly on the basis of my own investigations, I have given a description of the ramification, shoot-structure, flower-biology and anatomy of some Arctic and Subarctic Scrophulariaceae; in addition to which, under each species, the geographical distribution has been briefly mentioned, and, as far as the literature on the subject rendered it possible, the nature of the habitat.

Besides the herbarium and alcohol material belonging to the Botanical Museum of the University of Copenhagen, I have, through the courtesy of Mrs. Thekla Resvoll, Dr. phil., with respect to several of the species, had an opportunity of investigating some excellently preserved material, collected on the mountains of Norway.

The subject-matter of the present paper was worked out in the Plant-anatomical Laboratory of the University of Copenhagen, and I wish to express my grateful and heartfelt thanks to the Director, Professor C. Raunkiær, for his advice and help during the work.

The majority of the figures illustrating the structure of the flowers, are drawn by Professor Warming, to whom also my most sincere thanks are due, partly on account of the interest he has taken in my work, and partly because he so

generously placed his notes on the Arctic Scrophulariaceae at my disposal. Fig. 20, *B*, *C* and *D*, Fig. 40 and Fig. 44, which are published here for the first time, have been redrawn after Professor WARMING's originals, in order to be reproduced according to the method employed here. The remainder of the figures are drawn by myself.

Mr. M. PORSILD, mag. sc., Director of the Danish Arctic Station, Greenland, has very kindly read through great parts of my manuscript, and made several additions of a biological nature, besides having also kindly permitted me to use his notes on the geographical distribution of Arctic plants. For the help thus rendered to me I herewith beg him to accept my best thanks.

The following species have been investigated: —

Veronica fruticans Crantz.
— *alpina* L.
— *officinalis* L. f. *glabrata* Fristedt.
Castilleia pallida (L.) Kunth.
Euphrasia arctica Lange.
Bartschia alpina L.
Pedicularis lapponica L.
— *sudetica* Willd.
— *euphrasioides* Steph.
— *Sceptrum carolinum* L.
— *capitata* Adams.
— *hirsuta* L.
— *lanata* (Willd.) Cham. & Schlecht.
— *flammea* L.
— *Oederi* Vahl.

Principal literature.

ABROMEIT, J., 1899: Bot. Ergebnisse der . . . unter Leitung von Dr. von Drygalski ausgesandten Grönlandsexpedition. B. Samenpflanzen (Phanerogamen). (Bibliotheca botanica. 42. Stuttgart).

ANDERSSON, G. and H. HESSELMAN, 1900: Bidrag till kännedomen om Spetsbergens och Beeren Eilands kärlväxtflora, grundade på iakttagelser under 1898 års svenska polarexpedition. (Bihang till K. Svenska Vet.-Akad. handlingar. Bd. 26. Afd. III. No. 1).

AURIVILLIUS, C., 1883: Insektlifvet i arktiska länder. (Nordenskiöld: Studier och forskningar föranledda af mina resor i höga norden. VI. Stockholm).

AXELL, S., 1869: Om anordningarna för de fanerogama växternas befruktning. Stockholm.

BLYTT, A., 1906: Håndbog i Norges flora. Kristiania.

BRUNDIN, J. A. Z., 1898: Bidrag till kännedomen om de svenska fanerogama örternas skottutveckling och öfvervintring. Dissertation. Upsala.

BØRGESEN, F., 1895: Bidrag til Kundskaben om arktiske Planters Bladbygning. (Botanisk Tidsskrift. Kjøbenhavn. Bd. 19. — Resumé français: Journal de botanique. Vol. IX. 1895).

CLEVE, ASTRID, 1901: Zum Pflanzenleben in Nordschwedischen Hochgebirgen — Einige ökologische und phänologische Beiträge. (Bihang till K. Svenska Vet.-Akad. handlingar. Bd. 26. Afd. III. No. 15).

DUSÉN, P., 1901: Zur Kenntnis der Gefässpflanzen Ostgrönlands. (Bihang till K. Svenska Vet.-Akad. handlingar. Bd. 27. Afd. III. No. 3).

EASTWOOD, ALICE, 1902: A Descriptive List of the Plants collected by Dr. F. E. Blaisdell at Nome City, Alaska. (Botanical Gazette. Vol. 33).

EKSTAM, O., 1897: Einige blütenbiologische Beobachtungen auf Novaja Semlja. (Tromsø Museums Årshefter. 18. 1895).

— , 1899: Einige blütenbiologische Beobachtungen auf Spitzbergen. (Tromsø Museums Årshefter. 20. 1897).

FREIDENFELT, 1904: Der anatomische Bau der Wurzel in seinem Zusammenhange mit dem Wassergehalte des Bodens. (Bibliotheca botanica. 61. Stuttgart).

GOEBEL, K., 1897: Morphologische und biologische Bemerkungen. 7. Ueber die biologische Bedeutung der Blatthöhlen bei Tozzia und Lathraea. (Flora. Bd. 83).

Groom, Percy, 1897: On the Leaves of Lathraea squamaria and of some allied Scrophulariaceae. (Annals of Botany. Vol. XI).

Haberlandt, G., 1897: Zur Kenntniss der Hydatoden. (Pringsheims Jahrbücher. Bd. 30).

Hartz, N., 1894: Botanisk Rejseberetning fra Vest-Grønland 1889—1890. (Medd. om Grønland. 15. Hefte. Kjbh. 1898).

— , 1895 (I): Østgrønlands Vegetationsforhold. (Ibidem. 18. Hefte. Kjbh. 1896).

— , 1895 (II): Fanerogamer og Karkryptogamer fra Nordøst-Grønland, c. 75°—70° N. Br., og Angmagsalik, c. 65° 40′ N. Br. (Ibidem. 18. Hefte. Kjbh. 1896).

— and Chr. Kruuse, 1911: The Vegetation of Northeast Greenland, 69° 25′ lat. n.—75° lat. n. (Ibidem. 30. Hefte. Kjbh. 1911).

Heinricher, H., 1898—1910: Die grünen Halbschmarotzer. I—VI. (Pringsheims Jahrbücher. Bd. 31, 32, 36, 37, 46, 47).

Hollstein, O., 1907: Beiträge zur vergleichenden Anatomie der Stengel und Rhizome von dicotylen Alpenpflanzen. Dissertation. Göttingen.

Holm, Th., 1885: Novaia-Zemlia's Vegetation, særligt dens Phanerogamer. (Dijmphna-Togtets zoologisk-botaniske Udbytte. Kjbh. 1885).

Hovelacque, M., 1888: Recherches sur l'appareil végétatif des Bignoniacées, Rhinanthacées, Orobanchées et Utriculariées. Paris.

Huchedé, 1907: Veronique et Gratiole. Thèse. Paris.

Jungner, J. R., 1894: Klima und Blatt in der Regio alpina. (Flora. Bd. 79).

Jørgensen, E., 1919: Die Euphrasia-Arten Norwegens. (Bergens Museums Årbok. 1916—17. Naturvidenskab. række. No. 5).

Kerner v. Marilaun, A., 1898—1900: Pflanzenleben. Bd. I—II. Leipzig u. Wien.

Kjellman, F. R., 1882 (I): Sibiriska nordkustens fanerogamflora. (Vega-expeditionens vetenskapliga iakttagelser. Bd. I. Stockholm).

— , 1882 (II): Fanerogamfloran på Novaja-Semlja och Wajgatsch. (Ibidem).

— , 1882 (III): Om tschuktschernas hushållsväxter. (Ibidem).

— , 1882 (IV): Asiatiska Beringssunds-kustens fanerogamflora. (Ibidem).

— , 1883: Ur polarväxternas lif. (Nordenskiöld: Studier och forskningar föranledda af mina resor i höga norden. VII. Stockholm).

— and A. N. Lundström, 1882: Fanerogamer från Novaja-Semlja, Wajgatsch och Chabarova. (Vega-expeditionens vetenskapliga iakttagelser. Bd. I. Stockholm).

Knuth, P., 1899: Handbuch der Blütenbiologie. Bd. II. Teil 2: Lobeliaceae bis Gnetaceae. Leipzig.

Koch, E., 1895: Über die systematische Bedeutung der anatomischen Charaktere der Scrophulariaceen. Dissertation. Erlangen.

Kruuse, Chr., 1898: Vegetationen i Egedesminde Skjærgård. Medd. (om Grønland. 14. Hefte. Kjbh. 1898).

— , 1905: List of the Phanerogams and Vascular Cryptogams found on the coast, 75°—66°20′ lat. N. of East Greenland. (Ibidem. 30. Hefte. Kjbh. 1911).

— , 1906: List of Phanerogams and Vascular Cryptogams found in the Angmagsalik District on the East coast of Greenland between 65°30′ and 66°20′ lat. N. (Ibidem).

— , 1911: Rejser og botaniske Undersøgelser i Øst-Grønland mellem 65°30′ og 67°20′ i Årene 1898—1902 samt Angmagsalik-Egnens Vegetation. (Medd. om Grønland. Bd. XLIX. Kjbh. 1912).

Lange, J., 1871: Bemærkninger om frøenes form og skulptur hos beslægtede arter i forskellige slægter. (Botanisk Tidsskrift. Kjbh. Bd. 4).

— , 1880: Conspectus Florae Groenlandicae. (Medd. om Grønland. 3. Hefte. Kjbh. 1880).

— , 1887: Tillæg til Fanerogamerne og Karsporeplanterne i Consp. Flor. Groenl. (Ibidem. 3. Hefte. Fortsættelse. Kjbh. 1887).

Leist, 1889: Ueber den Einfluss des alpinen Standortes auf die Ausbildung der Laubblätter. (Mitth. der naturforsch. Gesellschaft von Bern).

Lindman, C. A. M., 1887: Bidrag till kännedomen om skandinaviska fjellväxternas blomning och befruktning. (Bihang till K. Svenska Vet.-Akad. handlingar. Bd. 12. Afd. III. No. 6).

Lundager, A., 1912: Some Notes concerning the Vegetation of Germania Land, North-East Greenland. (Medd. om Grønland. Bd. XLIII. Kjbh. 1917).

Müller, H., 1881: Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassungen an dieselben. Leipzig.

Nathorst, A. G., 1883: Nya bidrag till kännedomen om Spetsbergens kärlväxter och dess växtgeografiska förhållanden. (K. Svenska Vet.-Akad. handlingar. Bd. 20. No. 6).

Norman, J. M., 1895: Norges arktiske Flora. II. Kristiania.

Ostenfeld, C. H., 1901: "Phanerogamae and Pteridophyta" in "Botany of the Færöes". Vol. I, Kjbh.

— , 1908: The Land-Vegetation of the Færöes. (Ibidem. Vol. III).

— , 1915: Plants collected during the First Thule Expedition to Northernmost Greenland. (Medd. om Grønland. Bd. LI. Kjbh. 1915).

— and A. Lundager, 1910: List of Vascular Plants from North-East Greenland (N. of 76° N. lat.), collected by the Danmark-Expedition 1906—1908. (Medd. om Grønland. Bd. XLIII. Kjbh. 1917).

Poppius, B. R., 1903: Blombiologiska iakttagelser. (Acta soc. pro fauna et flora fennica. 25).

Porsild, M. P., 1902: Bidrag til en Skildring af Vegetationen på Øen Disco etc. (Medd. om Grønland. 25. Hefte. Kjbh. 1902).

— , 1910: The Plant-Life of Hare-Island off the coast of West-Greenland. (Ibidem. Bd. XLVII. Kjbh. 1911).

— , 1912: Vascular Plants of West-Greenland between 71° and 73° N. lat. (Ibidem. Bd. L. Kjbh. 1912).

— , assisted by A. Erling Porsild, 1920: The Flora of Disco Island and the adjacent coast of West-Greenland from 66°—71° N. lat. etc. (Ibidem. Bd. LVIII. Kjbh.).

Raunkiær, C., 1907: Planterigets Livsformer og deres Betydning for Geografien. Kjbh.

Resvoll, Thekla R., 1917: Om planter som passer til kort og kold sommer. (Archiv for mathematik og naturvidenskab. Bd. XXXV. Kristiania).

Rosenvinge, L. Kolderup, 1892: Andet Tillæg til Grønlands Fanerogamer og Karsporeplanter. (Medd. om Grønland. 3. Hefte. Fortsættelse. Kjbh. 1887).

— , 1896 (I): Nye Bidrag til Vest-Grønlands Flora. (Ibidem. 15. Hefte. Kjbh. 1898).

— , 1896 (II): Det sydligste Grønlands Vegetation. (Ibidem 15. Hefte. Kjbh. 1898).

Scherffel, A., 1888: Die Drüsen in den Höhlen der Rhizomschuppen von Lathraea squamaria L. (Mitth. a. d. Bot. Inst. zu Graz. V. 1888. Jena).

Schröter, C., 1908: Das Pflanzenleben der Alpen. Zürich.

Silén, F., 1905: Blombiologiska iakttagelser i Kittila Lappmark. (Medd. af soc. pro fauna et flora fennica. 31).

Simmons, H. G., 1906: The Vascular Plants in the Flora of Ellesmereland. (Report of the second Norwegian Arctic Expedition in the "Fram", 1898—1902. No. 2. Kristiania).

— , 1913: A Survey of the Phytogeography of the Arctic American Archipelago, etc. (Lunds Universitets Årsskrift. N. F. Afd. 2. Bd. 9. No. 19).

Skottsberg, C., 1901: Einige blütenbiologische Beobachtungen im ark. Teil von schwedisch Lappland 1900. (Bihang till K. Svenska Vet.-Akad. handlingar. Bd. 27. Afd. III. No. 2).

Sylvén, N., 1906: Om de svenska dicotyledonernas första förstärkningsstadium etc. I—II. (K. Svenska Vet.-Akad. handlingar. Bd. 40. No. 2).

Wagner, A., 1892: Zur Kenntniss des Blattbaues der Alpenpflanzen und dessen biologischer Bedeutung. (Sitzungsber. der kaiserl. Akad. der Wissenschaften in Wien. Matem.-naturw. Classe. Bd. CI. Abth. I).

Warming, Eug., 1884: Om Skudbygning, Overvintring og Foryngelse. (Naturhistorisk Forenings Festskrift. Kjbh.).

— , 1886: Om Bygningen og den formodede Bestøvningsmåde af nogle grønlandske Blomster. (Oversigt o. d. Kgl. Danske Vid. Selsk. Forhandl. Kjbh.).

— , 1888: Om Grønlands Vegetation. (Medd. om Grønland. 12. Hefte. Kjbh. 1888).

— , 1890: Biologiske Optegnelser om grønlandske Planter. 3. Scrophulariaceae. (Botanisk Tidsskrift. Kjbh. Bd. 17).

R. v. Wettstein, R., 1896: Monographie der Gattung Euphrasia. Leipzig.

Volkart, 1899: Untersuchungen über den Parasitismus der Pedicularis-Arten. Dissertation. Zürich.

Veronica fruticans Crantz (*V. saxatilis* Scop.).

Alcohol-material from Greenland (Julianehaab, leg. Lützen, 3. 7. 1887; Præstefjældet, leg. E. Warming, 2. 8. and 6. 8. 1884) and Northern Norway (Kåfjord, leg. E. Warming, 15. 7. 1885). — Herbarium-material from Greenland, Iceland, the Færöes and Fennoscandia.

Lit.: Axell, 1869, p. 102; Lange, 1880, p. 73; 1887, p. 261; Müller, 1881, p. 267; Warming, 1888, pp. 35, 75 and 87; 1890, p. 203; Rosenvinge, 1892, p. 685; 1896 (II), pp. 128, 144, 161; Wagner, 1892, pp. 8 and 21; Hartz, 1894, pp. 9 and 57; 1895 (I), pp. 273, 289; 1895 (II), p. 335; Hartz and Kruuse, 1911, pp. 352, 357, 359 and 409; Koch, 1895, p. 117 et seq. and p. 127; Norman, 1895, p. 452; Knuth, 1899, p. 167; Porsild, 1902, p. 230; 1920, p. 141; Huchedé, 1907, p. 72, fig. IV, B^2, fig. V, C^3, and fig. VI, C^5; Sylvén, 1906, p. 80; Kruuse, 1905, p. 175; 1906, p. 248; 1911, in part IV pp. 202, 207, 243, 261 and 262, besides many notes in the preceding parts; Schröter, 1908, pp. 221 and 656.

An evergreen, nanophyllous[1], sympodial under-shrub-chamæphyte which has a main root that dies away early (according to Sylvén), and develops adventitious roots fairly abundantly; the winter-buds are raised at most a few cm above the surface of the ground; older, vigorous specimens form small tufts (Kruuse, 1906, p. 248). The shoot-development extends over two years; during the first year a horizontal or obliquely-ascending part is developed, only a few cm long and furnished with a few (3—7) pairs of foliage-leaves; the next year the shoot

[1] C. Raunkiær: Om Bladstørrelsens Anvendelse i den biologiske Plantegeografi (Bot. Tidsskrift, Kjbh., Bd. 34, 1916).

usually continues its growth in a vertical direction, larger leaves are developed, and the growth can be terminated by a few-flowered raceme without a terminal flower. Special bud-scales do not occur; during the winter-rest the point of the axis is protected by the uppermost, not yet expanded pair of foliage-leaves, which are in contact with each other by their hairy margins. After the fruit has ripened, the stem dies as far down as to somewhat above the boundary line between the 1st and 2nd year's growth; the perennial basal portions bear the innovation shoots. Principal buds proper do not occur, but the uppermost buds appear generally to be the most advanced, and it is evidently especially these buds which produce the flower-bearing axes, while the lower ones often produce only small, weak, few-leaved shoots which — as recorded by WARMING (1890. p. 205) and as also shown in Fig. 1 — may be somewhat runner-like and furnished with only a few small leaves. The specimen illustrated in Fig. 1 is rather scantily branched; each of the floral shoots has only two real "innovation-buds", and of their parent-shoots the one to the left has also had two, of which one has developed into a vegetative shoot; the parent-shoot to the right is somewhat more richly equipped: in addition to the lowermost quite small shoot it bears two opposite floral shoots, and in the axils of the next pair of leaves two more shoots, of which the one (cut-off) was floral. Such a difference



Fig. 1. *Veronica fruticans.* (Greenland. Præstefjældet. 2. 8. 1884). (About nat. size.)

between shoots from two opposite leaves, that the one becomes vigorous and floral, and the other vegetative only, is very common; it appears to be the rule that the shoot which turns outwards towards the periphery of the tuft, becomes more vigorous. It happens not rarely, however, that the short, vegetative shoots are later on instrumental in the formation of floral shoots, in that the latter arise as lateral shoots upon them; in such a case the part of the parent-shoot above these lateral shoots dies away, as is the case in the floral shoot. The development of the lateral shoots usually takes place in the second year of the parent-shoot, and consequently simultaneously with the flowering.

The Leaves are rather thick, entire or slightly serrate; on the median rib and along the margin there is a sparse covering of non-glandular hairs; such are also found on the stem and in the floral region, viz., on the calyx and ovary. In the Botanical Garden in Copenhagen the leaves on the new innovation-shoots, developed during the last summer, remain green and fresh during the winter; on the flowering shoots, in my herbarium-material, the leaves from the previous year were withered in some cases; most often, however, they were green.

As a rule, the basal portion of the shoots takes root abundantly, and is drawn down by the roots to the surface of the ground; in the individual illustrated in Fig. 1, which has a somewhat more erect growth than is generally the case, adventitious roots are only scantily produced; the roots are developed at the earliest in the second year of the shoots.

The basal portions of the shoots have growth in thickness and may live several years; an individual from Greenland (Ikalik) had a prostrate stock, 4 mm thick, which showed 16 annual rings.

The Flower-biology has been investigated by H. MÜL-

LER (the Alps) and E. WARMING (Greenland and Northern Norway). The flowers are large and conspicuous; also in the Arctic regions, as a rule, they are of a pure and bright colour; but according to M. PORSILD, in northern Greenland a white-flowering variety may commonly occur. The ultimate diameter of the corolla is very constant, being 10—12 mm in material from the different localities; I found it to be particularly large in some material from Iceland, viz. 14 mm (in the Alps, according to Müller, only 6—7 mm). "The corolla-tube and the throat is white, and furnished with a wreath of hairs; then follows a dark, brown or reddish ring and then the deep-blue limb. The corolla-tube is $1^1/_2$—$2^1/_2$ mm in length (according to Müller 3 mm). As in the Alps the filaments taper very much at the base, are about 5 mm in length and, as the pistil is of the same length, the stigma and anthers stand at the same level. The flowers are homogamous. In fully expanded flowers self-pollination appears to be able to take place only with difficulty, as the stamens diverge so much laterally and the anthers are thereby removed from the stigma on the straight outstretched style; but self-pollination might have taken place at an earlier point of time, for I have seen a flower (from Greenland at 67° N. lat., Aug. 6) which, perhaps on account of gloomy and rainy weather, was only slightly expanded and in which the one anther was open, so that the pollen fell out of it down upon the stigma which stood close to it and which appeared to be fully ripe. The ovary is covered with small upwardly directed, adpressed hairs, and the style is 2—3 times longer than the ovary. Ripe fruit is produced in West Greenland at least up to 70° N. lat." (E. WARMING, 1890, p. 203).

V. fruticans is homogamous also according to AXELL and H. MÜLLER. The style, however, appears to me to be always slightly longer than the anthers; the outspread posi-

tion of the latter is distinctly seen in Fig. 5, *C*; the figure is drawn from living material from the Botanical Garden in Copenhagen.

According to M. PORSILD, near its northern limit in Greenland it flowers late and even sets fruit; but it is only in favourable, dry autumns, without too much frost, that its seeds ripen. Unripe fruits live through the winter, but perish without developing further. The structure of the shoots explains, as in *V. alpina* (TH. RESVOLL), the late flowering. There was, however, ripe fruit to hand from all localities. KRUUSE (1906, p. 248) in the Angmagsalik-district notes "abundant ripe fruit".

Geographical Distribution according to LANGE: Greenland, the Ural Mountains, Lapland, Finmark, Norway, Iceland, Great Britain, the Alps and the Pyrenees. Besides this it is recorded from the Færöes. Its certainly known north limit in West Greenland is 70°17′ on the continent (Vajgattet), from 70°—67° it occurs in isolated specimens only, and not until further southwards is it common; consequently, in Greenland it belongs to the southern types (M. PORSILD). In East Greenland it occurs as far north as the Scoresby-Sound-district (HARTZ and KRUUSE, 1911).

According to WARMING (1888) and ROSENVINGE (1896 (II)) in West Greenland the species grows in willow-copses, birch-copses and on "herb-slopes", and in places whence snow melts early it can ascend as high up in the mountains as 750 metres (LANGE, 1880: in grass-covered, open places, in rocky clefts). M. PORSILD informs me in confirmation of this that its natural habitat is the edge of the willow-copse, there it grows on warm, sunny slopes which are not too dry; the species thrives but badly when overshadowed; it needs snow-covering throughout the winter but must be early freed from snow; at its north limit it

does not at any rate belong to the real snow-flora. In the Scoresby-Sound-district it is found "in particularly well sheltered luxuriant, humid, herby slopes with high snow-cover in winter," but here it is very rare (KRUUSE, 1905, p. 175). In the Angmagsalik district, where it is somewhat more common (KRUUSE, 1906, p. 248), besides growing on the herby-slopes, it is also noted from the "steps of steep rocks above the slopes." According to NORMAN, in Northern Norway the species is found on all kinds of stony substrata rather than on grassy ground, and "it very much prefers the sunny side, especially the side facing directly south, and occurs only very rarely on the indifferent (eastern and western) sides". In the Alps it is recorded from "Schneeblössen" (SCHRÖTER, p. 656), spots where the wind sweeps the snow away in winter time.

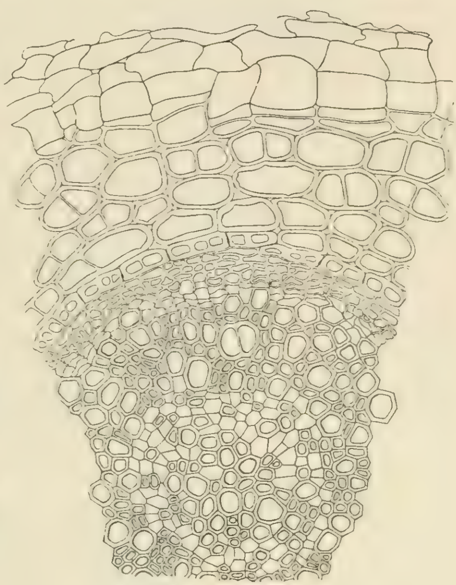


Fig. 2. *Veronica fruticans.* Transverse section of an adventitious root (about $^{230}/_{1}$). (Greenland.)

Anatomy. The Root. The epidermis of the adventitious roots dies away early; the outermost layer of the cortex is developed as an exodermis with cuticularised walls. Even before any secondary growth has taken place in the stele, a cork-cambium is developed in the layer under the exodermis, which is instrumental in the formation of a few-

layered cork (cf. Fig. 2). The walls of the primary cortex attain a rather considerable thickness; this is especially the case as regards the endodermis; both in this and in the

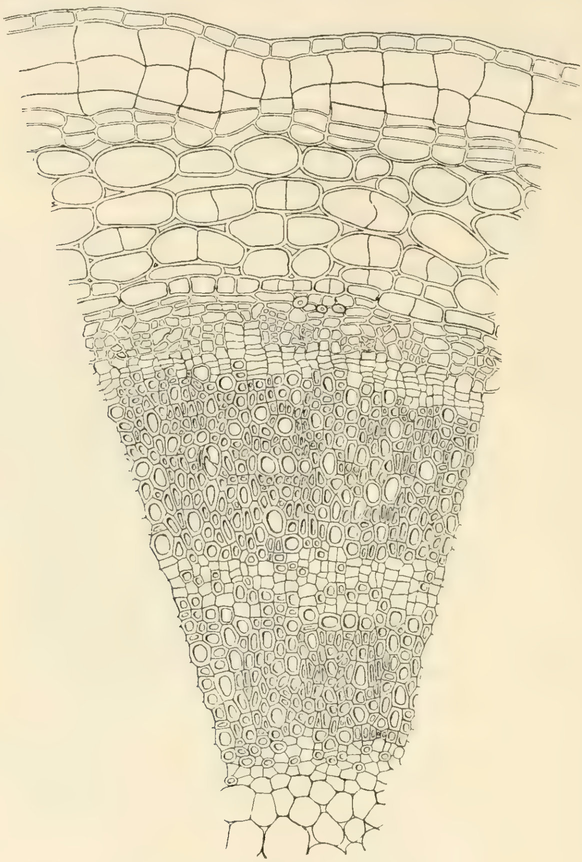


Fig. 3. *Veronica fruticans.*
Transverse section of the stem (about $^{200}/_{1}$). (Greenland.)

other layers, radial walls are formed during the secondary growth of the root.

In the wood of the 2-year-old root illustrated in Fig. 2, an annual ring is formed outside the central part which was developed during the first year; the limit between them is

easily discernable, since they are separated by a zone in which the vessels and wood-fibres are intermixed with non-lignified, axially elongated parenchymatous elements.

The Stem. In the lower persistent parts of the stems, a cork-cambium commences activity during their second year; it appears in the outermost layer of the cortex and forms a few-layered cork (Fig. 3). The cells of the primary cortex are rather thick-walled and show division by radial walls; they contain chlorophyll-grains. The endodermis has very distinct Casparian dots (as in the root). In the pericycle small groups of hard-bast cells are found. The figure shows a portion of the transverse section of a stem with apparently two growth-rings; between the two rings consisting of vessels and wood-fibres there is a zone intermixed with thin-walled and non-lignified cells; however, in reality the stem is 3 years old; during the first year only the innermost zone of the xylem with the small scattered vessels being developed. According to whether the shoots during the first year succeed in becoming more or less vigorous, so also does the thickness of the xylem of the first year vary; shoots may sometimes be found in which a continuous wood-ring has been developed as in the following years.

In the upper part of the shoot which dies away, no cork-formation takes place, the cortical cells are less thick-walled than in the lower part and richer in chlorophyll and Casparian dots are less distinctly developed. Hard bast is wanting or is scantily present in the pericycle, and the wood-ring is quite narrow. From all the axial organs medullary rays are quite absent.

The Anatomy of the Leaf has been investigated by Koch and Huchedé; my investigations entirely bear out the conclusions arrived at by them. The epidermal cells of

both the upper and lower surface have undulating lateral walls, those of the epidermal cells of the lower surface are however more strongly undulating; under a higher magni-

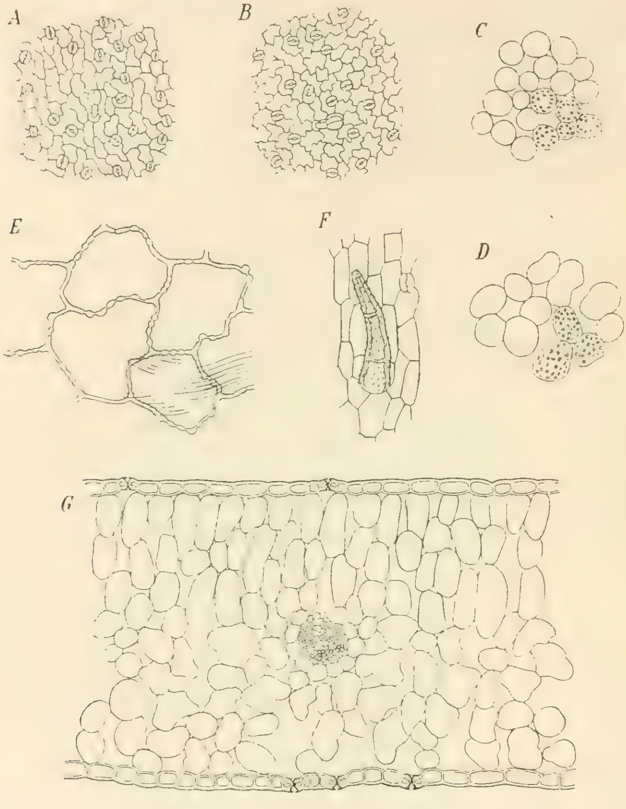


Fig. 4. *Veronica fruticans.*
A, Epidermis of the upper, and *B* of the lower surface of the leaf. *C* and *D*, The uppermost and lowermost layer of the mesophyll respectively, shown in surface view. *E*, Epidermal cells from the upper surface of the leaf, more highly magnified. *F*, A non-glandular hair from the mid-rib. *G*, Transverse section of the leaf (*A* and *B* about $^{90}/_{1}$; *C*, *D*, *F* and *G* about $^{115}/_{1}$; *E* about $^{375}/_{1}$). (Greenland.)

fication the lateral walls are seen to be as shown in Fig. 4. *E*: pores and nodose thickenings alternate. The outer walls have fine cuticular striations. Stomata are almost equally

distributed on both surfaces of the leaf, I found them however (contrary to Wagner's statement) to be slightly in the majority on the lower surface; the absolute number per square unit proved, however, to vary somewhat, but I did not succeed in finding any fixed rule as regards this point. The stomata are on a level with the surface of the leaf.

One of the non-glandular hairs occurring on the leaf-margin and the under-side of the midrib is shown in Fig. 4, *F*; they are 2—4 celled, thick-walled and have cuticular warts on the surface. Glandular hairs with a one-celled stalk and two-celled head occur in great numbers and are equally abundant both on the upper and the lower surface of the leaf (Fig. 4, *A* and *B*). A transverse section discloses 2—3 layers of short and broad palisade-cells with rather large intercellular spaces; the spongy parenchyma consists of ovate to slightly branched cells; all the cells of the mesophyll are abundantly filled with chlorophyll-grains. Palisade tissue and spongy parenchyma are shown in surface view in Fig. 4, *C* and *D*. The mid-rib has on its under-side a thin layer of stereom.

Veronica alpina L.

Alcohol-material from Norway (Tromsö, leg. E. Warming, 21. 7. 1885; Muggrubskampen, Röràs, leg. Th. Resvoll, 29. 7. 1918) and Greenland (Nunatsuk, 11. 8. 1885; Ivigtut and Dronning Louises Ø, leg. P. Eberlin, 21. 8. 1883 and 8. 8. 1885). — Herbarium-material from Greenland, Iceland, the Færöes and Fennoscandia.

Lit.: Axell, 1869, p. 102; Lange, 1880, p. 72; 1887, p. 261; Müller, 1881, p. 270; Lindman, 1887, p. 81; Warming, 1888, pp. 31, 35, 39, 75, 87, 93 and 142; 1890, p. 204; Rosenvinge, 1892, p. 685; 1896 (II), pp. 128, 161, 168; Wagner, 1892, pp. 9 and 20; Hartz, 1894, pp. 9, 49, 50 and 57; 1895 (I), pp. 137, 170, 179, 266, 271, 288 and 304; 1895 (II), p. 335; Hartz and Kruuse, 1911, pp. 346, 359, 364, 409, 417 and 423; Jungner, 1894, p. 275; Koch, 1895, pp. 117 et seq. and

128; Norman, 1895, p. 452; Kerner, 1898, p. 350; Knuth, 1899, p. 171; Cleve, 1901, pp. 12, 16, 25, 40, 57 and 89; Eastwood, 1902, p. 292; Porsild, 1902, pp. 119, 181 and 209; 1910, p. 267; 1920, p. 140; Kruuse, 1905, p. 175; 1906, p. 248; 1911, in part IV pp. 196, 202, 229, 230, 242, 247, 255, 261, 262, besides many notes in the preceding parts; Sylvén, 1906, p. 80; Huchedé, 1907, p. 73, fig. IV, A^5, fig. VI, C^1; Schröter, 1908, pp. 221, 226, 468 and 493; Th. Resvoll, 1917, p. 208.

Nanophyllous sympodial chamæphyte with primary root which dies away early (Sylvén), and abundant development of adventitious roots from the stem-bases, this in conjunction with the fact that the older shoots gradually die away, determines the vegetative reproduction, enabling the plants to form lax, but large tufts (Kruuse, 1906, p. 248). The winter-buds either rest upon, or are slightly raised above, the surface of the ground.

The Shoot-development has been described by Th. Resvoll; it is a process of two years duration, as in the foregoing species; the first-year's part of the shoots is either erect or obliquely ascending or quite horizontal, as in Th. Resvoll's Figs. 60 and 61; most often only 1—2 cm long and bearing a few small leaves. The next year the growth of the shoot is continued in a vertical direction, while essentially larger leaves are being formed; the shoot is frequently terminated by an inflorescence; the flowers are already formed during the autumn of the first year (l. c.). Special bud-scales do not occur, the end of the axis is only protected by the uppermost pair of leaves. After the fruit has ripened, the axis dies away to slightly above the "innovation-buds"; the latter occur, however, often rather far down on the shoots, even in the axils of the very first pair of leaves, which causes the branches of the sympodia to become very short, and the stems crowded.

Of the two shoots in the axils of two opposite leaves, the one may be far more vigorously developed than the

other; this is no doubt usually the case, and then it appears to be the shoot which is turned towards the periphery of the tuft which becomes the more vigorous and floriferous. When the plant grows in damp moss, the internodes of the horizontal, first-year portions of the shoots — as mentioned by TH. RESVOLL, and as I myself had an opportunity of verifying in the mountains of Norway — may become elongated, so that the shoots become almost runner-like; in this case the plant is capable of spreading considerably.

The longevity of the branches of the sympodium is greatly restricted; a growth in thickness of the axial organs, continuous for years as in *V. fruticans*, does not take place.

Adventitious Roots are developed in the second growth-period of the shoots, they arise in the neighbourhood of the nodes. The foliage-leaves are either entire or slightly serrate; I am not prepared to say whether the leaves occurring at the base of the shoots remain green throughout the winter, in the following summer they are at any rate always found in a withered condition.

The Flower. H. MÜLLER, LINDMAN, E. WARMING and KERNER have in the works cited above described the structure and biology of the flower, which according to these authors agree in the Alps, Scandinavia and Greenland, nor have I been able to find any differing features. "The small, dark blue flowers are at first only 2.5—3 mm in diameter, but may ultimately become 5—5.5 mm. They are protogynous-homogamous, and appear to be well-adapted to self-pollination. While the corolla is still almost tubular or funnel-shaped and consequently only slightly open, the anthers may be open and lie close to the stigma, which may be seen to be covered with pollen-grains, many of which are germinating. Afterwards the anthers are slightly removed from the stigma by the filaments bending backwards, but not so decidedly

as in *V. saxatilis*; the anthers are, indeed, not far from remaining parallel with the style, and are therefore constantly near the stigma" (Warming, 1890). Th. Resvoll records self-pollination (at Röràs, in sched.); Fig. 5, *A* and *B* show that this may easily take place; moreover, in scarcely expanded flowers I too found the anthers open and the stigma covered with pollen.

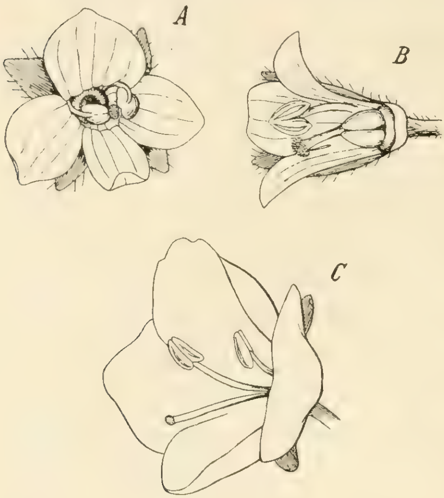


Fig. 5. *A*, and *B*, Flowers of *Veronica alpina* (Röràs, Norway, $^{29}/_{7}$). *A*, In front-view; *B*, in side-view, half of the calyx and of the corolla is removed. (About $^{5}/_{1}$). *C*, A flower of *Veronica fruticans*. (Hort. bot. Hauniens.) (About $^{4}/_{1}$.)

The ovary varies between the glabrous and finely-hairy condition.

Lindman remarks that the flowers open two at a time. They are, however, on the whole, not very conspicuous, and insect-visits are scarce.

By reason of the fact that there is no division of labour between the vegetative and purely floral shoots, the flowering period occurs late (Th. Resvoll). In Greenland *V. alpina* sets fruit abundantly, and ripens its seeds normally; the latter are scattered in autumn; wherever in Greenland *V. fruticans* and *V. alpina* occur in the same locality, the latter is always the first to flower (M. Porsild).

Geographical Distribution according to Lange: East and west coasts of Greenland, Labrador, the Rocky Mountains, western North America, Siberia, Arctic Russia,

Scandinavia to Lapland and Finmark, Iceland, Great Britain and the Alpine regions of Southern Europe. To these should be added the Færöes (Ostenfeld, 1901, p. 56). In West Greenland the northernmost limit is found on the Nugsuak-peninsula (70°42′); in East Greenland it passes over the Scoresby Sound.

Habitat. In West Greenland *V. alpina* grows in copses, on "herb-slopes", in snow-troughs (Snelejer) where the snow does not lie till very late in the summer, and on sandy flats near the shore (Warming, 1888; Rosenvinge, 1896 (II)). In East Greenland it is noted too from "herb-slopes", grassy-slopes and copses; besides, Kruuse, in the Angmagsalik district, has found it growing on the steps of steep rocks above the slopes. It is always well covered with snow during its winter-rest (cf. also Kruuse, 1905, p. 175 and Porsild, 1920, p. 140). Th. Resvoll mentions the species as a common plant of the snow-troughs in the whole of Norway; according to Norman it is also found by mountain-streams, in birch-wood glades, on inundated river-banks, on the coast and on mountain-summits. A. Cleve records: "Häufig und üppig ausgebildet in

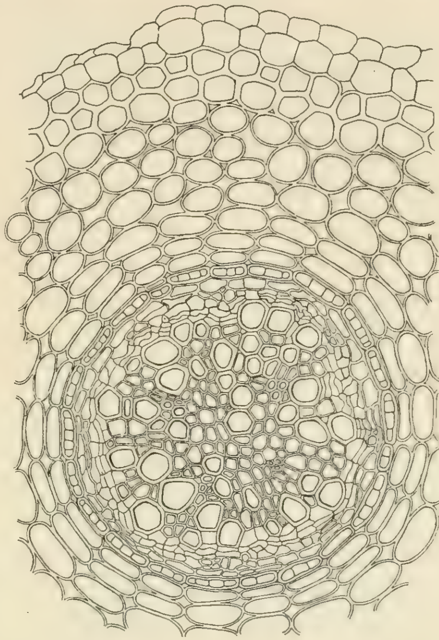


Fig. 6. *Veronica alpina.* Transverse section of an adventitious root (about $^{230}/_{1}$). (Norway.)

Sumpfwiesen, . . . Ferner häufig in der Moosmatte, dort noch mit Blüten und Knospen am $^6/_9$ und in rein vegetat. Individ. näher an dem ewigen Schnee als irgend eine andere Blütenpflanze beobachtet. Meidet dagegen entschieden trockene Heiden und Wiesen". Th. Resvoll, also, states that, in unfavourable localities, where the snow lies till late in the summer, *V. alpina* occurs as sterile specimens.

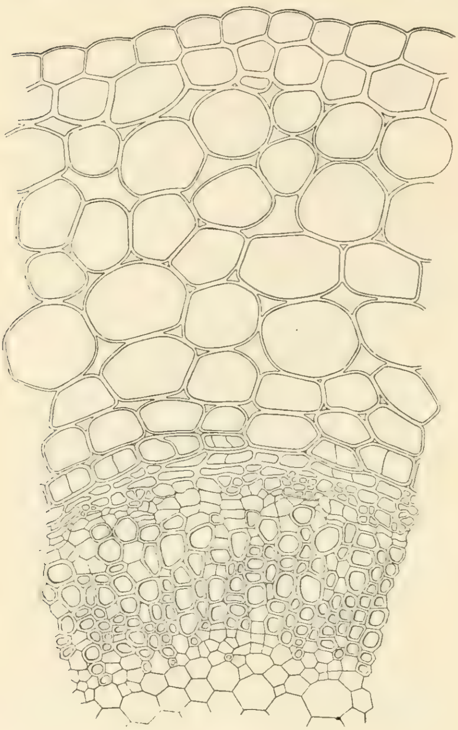


Fig. 7. *Veronica alpina.* Transverse section of a stem (about $^{230}/_1$). (Norway.)

In the Alps, as recorded by Schröter, the species is "einer der verbreitetsten Rasenbestandteile von der subalpinen bis zur nivalen Region (1500—3185 m in der Schweiz, 1560—2870 m in Bayern) alle Bodenarten bewohnend, indifferent gegen Düngung und Humusgehalt". Besides this, it occurs in snow-troughs (Schneethälchen).

Anatomy. The Root. The epidermis becomes cuticularised and persists a long time. The outermost layer of the cortex consists of thin-walled cells with cuticularised outer and lateral walls; the two succeeding layers within the cortex (Fig. 6), have, on the other hand, fairly thick-walled cells which unite mutually and with the exodermis

without intercellular spaces; the walls show the reaction of cellulose. During the growth in thickness of the stele, the endodermal cells are stretched tangentially, and become subdivided by 2—4 thin radial walls; the walls of the original endodermal cells show Casparian dots, but only faintly. The cortical cells contain starch; root-hairs occur in great numbers. In the xylem portion I have not found indication of annual rings (the root figured is several years old) as in the foregoing species; consequently, the roots complete their development in the course of one year. The xylem is composed of vessels and wood-fibres.

The Stem. As in *V. saxatilis* the xylem, in the first year of growth, when the shoots are but weak, frequently consists only of scattered vessels with intervening non-lignified parenchyma, and not until the second year is a continuous ring of vessels and wood-fibres formed, as shown in Fig. 7, which shows a portion of a transverse section of the basal, persistent part of the shoot. I never found more than 3 years' growth in thickness, not even in shoot-bases apparently older. The vessels are comparatively numerous, and the wood-fibres are more sparingly present and also more thin-walled than in the foregoing species. In the cells of the long-lived epidermis tannin is found; cork-formation does not take place, neither in the stem nor in the root. The cells of the cortex contain chlorophyll-grains. The young shoots are beset with glandular hairs of the same type as those on the leaf. In the upper part of the stem, which dies away after flowering, the wood-ring is of course formed entirely during one growth-period, here it is thinner than in the lower part; the cortical cells are thinner-walled and richer in chlorophyll, and the epidermis contains no tannin.

The Leaf. The epidermal cells of the upper surface have slightly, those of the lower surface more highly, un-

dulating lateral walls; they are thin and without pores (Fig 8, *D*). Stomata occur almost equally on both sides of the leaf, frequently they are slightly in the majority on the

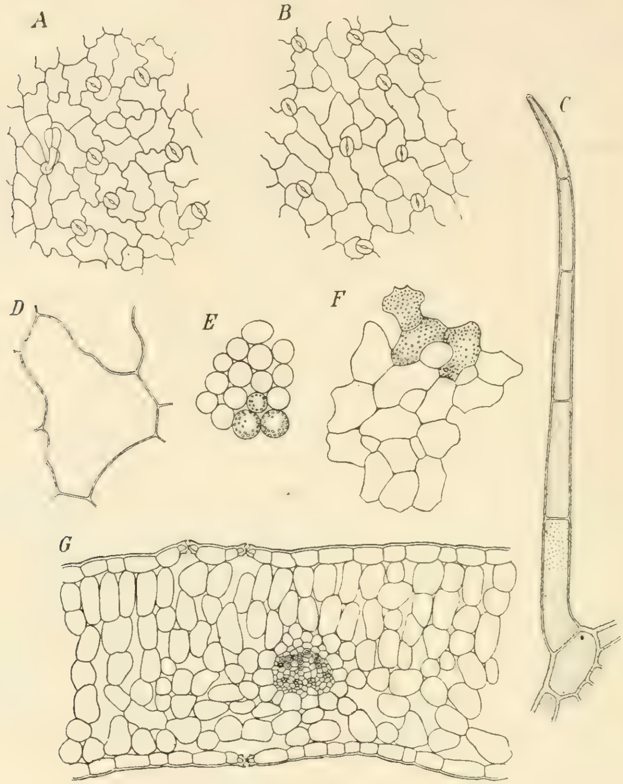


Fig. 8. *Veronica alpina.*
A, Epidermis of the lower surface of the leaf. *B*, Epidermis of the upper surface of the leaf. *C*, A non-glandular hair from the leaf-margin. *D*, An epidermal cell more highly magnified. *E* and *F*, The upper and lower layers respectively of the mesophyll, in surface view. *G*, Transverse section of the leaf (*A* and *B* about $^{90}/_{1}$; *C*, *E*, *F* and *G* about $^{115}/_{1}$; *D* about $^{375}/_{1}$). (Greenland. Dronning Louises Ø, 8. 8. 1885.)

upper surface; the stomata are on a level with the surface of the leaf. Both leaf-surfaces are furnished with glandular hairs of the usual type — a two-celled head on a one-

celled stalk; non-glandular hairs (Fig. 8, *G*) usually occur only along the leaf-margin.

The transverse section shows 2—3 layers of short and broad palisade cells with rather large intercellular spaces; the cells of the spongy parenchyma are somewhat more branched than in the foregoing species (cf. surface view, Fig. 8, *F*).

Chlorophyll-grains are abundantly present in the whole of the mesophyll; they are also found in the epidermis of the lower surface.

Veronica officinalis L.
(f. *glabrata* Fristedt).

In the collections preserved in the Botanical Museum in Copenhagen there is some material of *Veronica officinalis* collected in the Færöes, part of which belongs to the main form with hairy leaves, and part to f. *glabrata* Fristedt (Væxtgeografiska skildr. af Södra Ångermanland, Upsala, 1857). Of both forms there were individuals of normal size, as well as dwarf individuals.

The Morphology of the species has been described several times (e. g. Warming, 1884, p. 58; Brundin, 1898, p. 83), most exhaustively by the first-named author, from whose description the following is quoted: "The creeping and rooting shoots bear only foliage-leaves (evergreen); at the apex they are frequently bent slightly upwards in a curve, especially when the plant grows among moss; but gradually as the adventitious roots are developed in ascending succession, the stems are drawn down to the ground. From the basal portion of the year's shoots there proceeds shoots which resemble the parent shoot; in this species no lateral shoots are found which can be indicated as special "assimilatory shoots", which are such only, without taking at the same

time part in the vegetative propagation; from the leaf-axils which follow next, racemose inflorescences proceed. But after a short pause during the flowering period, the parent shoot continues its growth at the apex and, under favourable conditions, may also produce new lateral shoots, as also it may, it is true, continue its growth throughout the winter, as soon as the temperature has reached a certain degree of warmth. I have, however, observed several cases in which the main shoot had been biologically arrested through flowering, and had died away as far down as below the inflorescences."



Fig. 9. *Veronica officinalis* L. f. *glabrata* Fristedt. Kirkebökamp, Strömö (The Færöes). (About $^2/_1$).

A dwarf specimen of f. *glabrata* (Strömö, Kirkebökamp, leg. C. H. OSTENFELD, 8. 6. 1895) is illustrated in Fig. 9; it is drawn almost twice the natural size. The individual did not flower; the few leaves from the previous year which are still remaining, are recognizable by their being shaded. The branching is seen to be abundant — these dwarf individuals therefore often form rather dense tufts. Uppermost in the figure the last-formed leaves are seen to bend over the apex of the

shoot; the reason of this is unknown to me. Upon the oldest portion of the shoot-system which has been figured, adventitious roots are seen to be rather abundantly developed.

According to Raunkiær (1907, p. 46) *Veronica officinalis* is an active chamæphyte; the species is nanophyllous, and evergreen (see above).

In "Field-notes on the Biology of some of the Flowers of the Færöes" (Botany of the Færöes. Vol. III, p. 1065) E. Warming writes concerning *Veronica officinalis*: "The diameter of the flower is 7—8 mm. The corolla is pale-lilac with stripes of a darker colour. Homogamous. The anthers and the stigma occur at the same level, but as the stamens are spreading, insect-pollination appears to be necessary for the setting of fruit."

Geographical Distribution: Europe, Western-Asia, North-America.

According to Ostenfeld (1901, p. 57) in the Færöes *Veronica officinalis* is "Rather common in low-lying regions on hill-slopes and on rocky-ledges; also occurs at high levels and there mostly as f. *glabrata* Fristedt . . . Fl. beginning of July. Fr. August, but bears fruit sparingly; often fails altogether in the hills."

The specimen illustrated in Fig. 9 was investigated with respect to its leaf-anatomy. The epidermis of the upper surface (Fig. 10, *B*) had lateral walls, from straight to slightly undulating, and that of the lower surface (Fig. 10, *A*), rather strongly undulating lateral walls. Glandular hairs with one-celled stalk and two-celled head occurred abundantly on both leaf-surfaces. In Fig. 10, *C* some epidermal cells are shown under higher magnifying power; the two smaller and thin-walled ones have borne glandular hairs (the small

circles inside their outlines indicate the connection of the stalk of the gland with the outer wall of the cell), the lateral walls of the others are seen to be porose with nodose thickenings between the pores; in the main form I found these thickenings to be somewhat more strongly developed; they were very pronounced in individuals collected in dry habitats in Denmark. A transverse section of the leaf is shown in

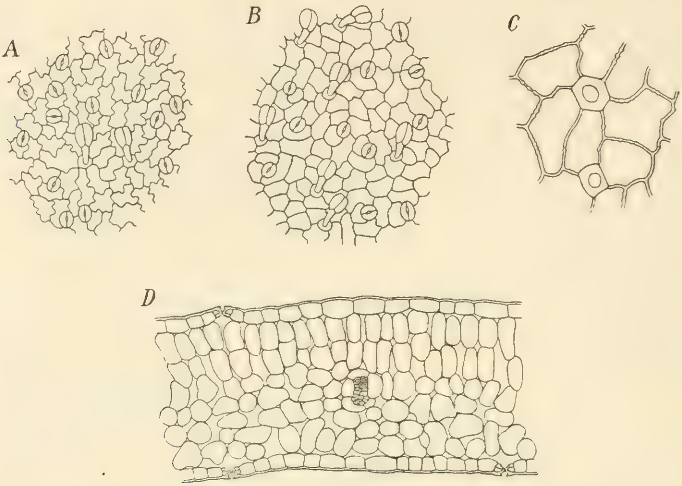


Fig. 10. *Veronica officinalis* L.
f. *glabrata* Fristedt.
A, Epidermis of the lower, and *B* of the upper surface of the leaf. *C*, Epidermal cells from the upper surface of the leaf, more highly magnified. *D*, Transverse section of the leaf. (*A* and *B* about $^{90}/_{1}$; *C* about $^{225}/_{1}$; *D* about $^{115}/_{1}$). (Kirkebökamp, Strömö (The Færöes)).

Fig. 10, *D*; in the upper part of the figure there are two layers of short and broad palisade-cells; the spongy parenchyma consists of rounded or slightly branched cells. Any special difference in the structure of the mesophyll in the Færöese and the Danish plants, could hardly be demonstrated; the description given by Koch (1895, p. 134) also agrees with that given above.

Fig. 10, *A* and *B*, which are drawn from epidermis-preparations of one of the leaves with the under surface turned upward, seen uppermost in Fig. 9, show the proportion between the number of the stomata on the upper and lower surface of the leaf to be about 2 to 3; in the normally orientated leaves of the same individual, there were, however, generally about 3 times as many stomata on the lower as on the upper surface. On the whole, I always found in all the individuals of *Veronica officinalis* investigated by me, by far the greater number of stomata on the lower surface of the leaf, viz., 3 to 5 times as many as on the upper surface — this feature, as well as the absolute number of the stomata per unit of area, may however vary in the different leaves on the same individual.

The non-glandular hairs, which are found in greater or fewer numbers on the leaves and stems of the main form, are multicellular, thick-walled, and have cuticular warts.

Castilleia pallida (L.) Kunth.

Alcohol material from Kola (the Voronej River, leg. Brotherus, 2. 7. 1887) and Arctic America (King Point and Herschell Island, leg. A. H. Lindström, 1905—1906). Herbarium material from Arctic America (Port Clarence, King Point and Herschell Island (var. *unalaschkensis* Cham.), Labrador, the coast of Hudson Bay (Ranken Inlet, Churchill (var. *septentrionalis* (Lind.) Gray)), *Lapponia imandrae.*

Lit.: Lange, 1880, p. 79; E. Warming, 1890, pp. 220—223, fig. 34; Rosenvinge, 1892, p. 687; P. Knuth, 1899, p. 193; Simmons, 1913, pp. 122 and 138.

Spot-bound, nano-microphyllous, sympodial proto-hemicryptophyte with a slightly branched primary root of long duration. Only one shoot-generation reaches maturity in each growth-period. The perennial basal portions of the shoots

live for several years, and can have growth in thickness; adventitious roots are developed but sparingly. The shoots are erect and hairy especially above in the floral part; if they are capable of flowering — which ordinarily appears to be the rule — they terminate in a raceme, the subtending leaves of which are large, the lower ones similar to the foliage-leaves, but often having long lobes.

In the axils of the 4—7 radical scale-leaves (bud-scales) of the shoots "innovation-buds" occur, but of these only 1—2 are further developed; the uppermost of them appear on the whole to be the most vigorous, but none of them is a decidedly principal bud. The foliage-leaves differ greatly in shape and size in the different forms in which the plant occurs; in var. *unalaschkensis* they are large, ovate-lanceolate (50—60 mm long, as much as 17 mm broad); in var. *septentrionalis* they are smaller, linear-lanceolate 30—40 mm long, 3—4 mm broad); the principal form is intermediate. Fruits with ripe seeds occurred in my material from the localities in Labrador and Hudson Bay; the fruit ripens in July—August. The seeds are small and light with a reticulated, pitted testa; this pattern is produced by the very thin outer walls of the outermost, large-celled layer of the seed-coat, sinking down into the cavity of each cell, while to the inner and lateral walls rigidity is given by a network of anastomosing flange-like thickenings.

The structure and biology of the flower has been exhaustively described by E. Warming, (l. c.), from whom I quote the following (compare also the accompanying figure with explanation which has been taken from the paper in question): "The hairy calyx is deeply cleft into two lateral lobes, which again are cleft into a larger anterior and a smaller posterior lobe, both oblong. Here the corolla is only of about the length of the calyx, tube-shaped and two-lip-

ped. The lower lip is shorter, with three ovate obtuse lobes which are erect or slightly reflexed; at the base of each lobe the lip is inflated into a bipartite arch (*A*, *B* and *G*). The upper lip is erect, boat-shaped, and terminates in an entire apex; a little distance below the apex it is provided on

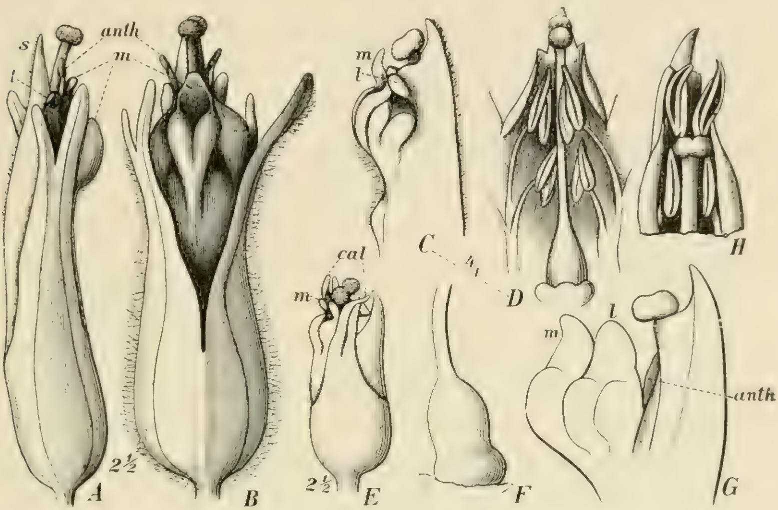


Fig. 11. *Castilleia pallida* (From Kola at the White Sea).
A and *B*, A flower seen from the right side and from the front; the anthers (*anth.*) have grown out of the flower and are open; the stigma protrudes above them; behind it the upper lip (*s*) is seen; the middle part of the lower lip is marked *m*, one of its lateral lobes (the right one) *l*. The hairs are indicated only along the periphery. *C* and *D*, Parts of a young flower, seen from the left side and from the front, after having been artificially opened. The anthers have not dehisced; *m* is the middle lobe of the lip, *l* one of its left lateral lobes. *E*, A flower from the same inflorescence as *A*, seen from the left side, but much younger and smaller; even here the stigma is large. *F*, Ovary of *A*. *G*, Each stigma in the whole inflorescence to which this flower belongs is as much enclosed as it is here; the anthers (*anth.*) of the long stamens are open, those of the short ones are closed. *H*, The relative positions of the stamens and stigma in the lowermost flower (14 mm long) in an inflorescence; the two uppermost anthers are open and are situated just above the stigma; the next flower appears to be similar; the third one was almost a bud, but had its stigma protruding to the usual distance. (Drawn by E. Warming).

either side with a rather thin wing (*D* and *G*), which in its upper part may be erect or curved slightly inwards around the anthers and stigma, while in its lower part the edge is revolute (*G*) as in *Pedicularis*, but the revolute portion ("die Rolle") is quite smooth here. As both lips are erect and close tightly, there is, between them, a very narrow entrance to the flower, through which, on the one hand, only very small flies and other small insects can creep in, and on the other hand, only butterflies and bees with long proboscides can gain entrance into the flower. The anthers of the long stamens open before those of the short ones (*H*), and the anthers of the latter always remain enclosed, while those of the long stamens protrude more or less. Here also the style appears to vary in length; in some infloresceneses I found it protruding far, even in quite young flowers — sometimes so young that they must rather be called buds (*E*); and as the stigma here also appears to be developed early, these flowers must be called longistylous—protogynous. In other flowers I found the stigma to protrude less, but nevertheless to be higher than the anthers, while in others again the long stamens were so long that their anthers were in contact with the stigma, or even protruded above the latter (*H*)." (The author then goes on to say, that among flowers from the same inflorescence there may be some difference as regards the relative length of the style, the stamens and the corolla which apparently cannot be referred to difference in age); "in flowers such as *A*, *B* and *E* (from the same inflorescence) self-pollination will be able to take place only with difficulty, the stigma being throughout higher than the anthers and the flower standing erect, hidden behind the large bracts provided with marginal lobes. Nor will self-pollination be easy in a flower like *G*, but in flowers like

H, self-pollination will be able to take place easily, as the pollen will almost inevitably fall upon the stigma."

To the above description I can add, that in all cases, I found in fully developed flowers, with the exception only of the flowers in two inflorescences from Kola, — which happen to belong to the material upon which WARMING has based his description — the stigma projecting more or less beyond the apex of the posterior lip, usually as in Fig. 11, *A* and *B*, sometimes projecting even more, and in quite young flowers somewhat less; in several cases I verified the presence of germinating pollen upon the stigma. It has not been possible to demonstrate conditions indicative of heterostyly. It does not appear to be uncommon for the pollen, at any rate in the anthers of the two longest stamens, to germinate even before the flower has entirely expanded, i. e. while it is still hidden by the large subtending leaf, and the corolla is surrounded by the lobes of the calyx. As the stigma, even at that time, protrudes beyond the lobes of the corolla, the distance between it and the anthers will, however, in all probability be so great that self-pollination will not be able to take place; in material from Kola there was a flower, like that figured in *H*, which had germinating pollen in the anthers.

Both calyx and corolla have a dense covering of shorter and longer non-glandular and glandular hairs, similar in form to those described below under the anatomy of the leaf. According to E. WARMING (l. c.) the flowers are visited by small wasps (the genus *Pteromalus*); he found such in several flowers.

The Geographical Distribution of the plant is, according to LANGE: Labrador, Canada, the Rocky Mountains, western Arctic North America, Kamchatka, East and Arctic

Siberia, and Arctic Russia. This author records it also from Greenland, but as it has not been found since, it ought to be omitted from the flora of Greenland (Rosenvinge, M. Porsild). According to Simmons the following localities from the Arctic North American archipelago can be added: Banks Land, Baring Land, Victoria Land.

Anatomy. The Root: The epidermis dies away quickly. The primary cortex follows for a long time the growth in thickness of the stele by tangential elongation of the cells, accompanied by divisions in these by radial walls. During the secondary growth the cambium forms outwards a large amount of parenchyma, arranged in very regularly radiating rows, while the formation of sieve-tissue is extremely sparing. The cells of the parenchyma are entirely filled with starch. In the woody parts the single growth-zones are easy to distinguish, in an inner narrow portion of the annual ring the vessels being surrounded by thin-walled cells, while in the outer larger part the vessels are accompanied by wood-fibres. Also in the thin-walled cells in question starch occurs. Parenchyma-rays are absent.

The Stem: As shown in Fig. 12, *A* and *B* the ring of wood in the lower, persistent part of the year's shoots is considerably thicker than in the upper, perishable part. In that part of the stem, from which the section shown in Fig. 12 *A* is taken, the epidermis, together with the outermost thick-walled cortical layer connected with it without intercellular spaces, has partly separated from the rest of the cortex; this happens especially at the nodes, thus a leaf occurred on the axis just above the plane of the section on the side turned upwards in the figure. At the base of the shoots slits are formed at some depth in the cortex (Fig. 12, *B* and *C*); this explains the fact that the cortex can so easily be rubbed off in flakes. The persistent basal portions of the

shoots have growth in thickness, but probably only to a very limited degree. In Fig. 12 *C* two annual-rings are seen, the last-formed is very excentric, the fact often being that the most vigorous growth in thickness takes place on that side of the stem which is opposite to a developing bud.

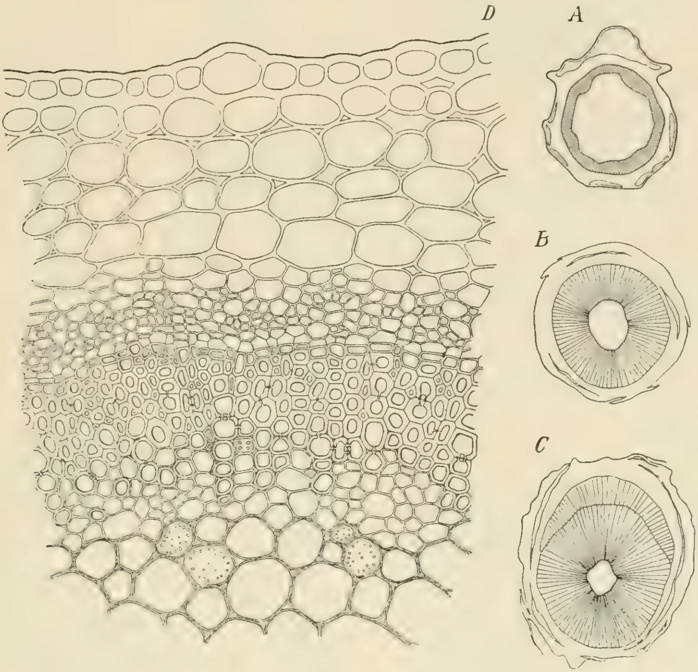


Fig. 12. *Castilleia pallida.*
A and *B*, Transverse sections of the stem of the year's shoot; *A* is taken from half-way up the stem, *B* from near the base. *C*, Transverse section of a 2-year-old, persistent stem-base. *D*, A portion of *A*, more highly magnified. (King Point.) (*A*, *B* and *C* about $^{10}/_{1}$; *D* about $^{230}/_{1}$.)

Fig. 12 *D* represents a part of *A* more highly magnified, the epidermis and the outermost layer of the cortex is thick-walled; the cortex is few-layered, its cells contain chlorophyll-grains; stomata occur in the epidermis. The endodermis is only demonstrable by faint Casparian dots.

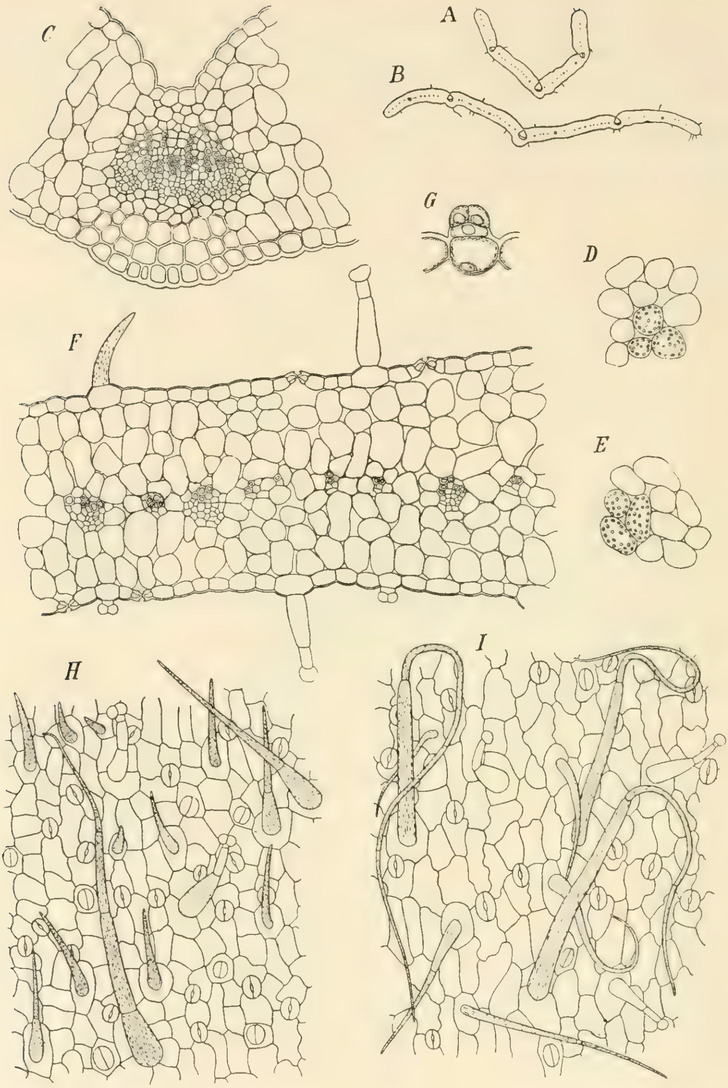


Fig. 13. *Castilleia pallida.*
A and *B*, Transverse section of leaves ($^5/_1$). *A*, var. *septentrionale* (Churchill); *B*, the principal form (Kola). *C*, Transverse section of the midrib of the leaf (Kola). *D* and *E*, The uppermost and lowermost layers of the mesophyll, seen in surface view. *F*, Transverse section of leaf. *G*, A glandular hair, more highly magnified. *H* and *I*, Epidermis from the upper and lower surface of the leaf respectively. (*D*, *E*, *F*, *H* and *I* King Point; *G* Kola.) (*C*, *D*, *E*, *F*, *H* and *I* about $^{90}/_1$; *G* about $^{220}/_1$.)

In the wood, medullary rays are entirely wanting (the radiating lines in Fig. 12, *A*, *B* and *C* indicate only the radial arrangement of the elements); exteriorly, the ring of wood consists chiefly of wood-fibres; interiorly, vessels become more frequent, and are accompanied by partly lignified parenchyma. In the basal portion of the stem the vessels are relatively more numerous than shown in Fig. 12, *D*, and the cells of the stereom are thinner-walled. The pith consists exteriorly of lignified, rather thick-walled, distinctly porose, axially elongated parenchymatous cells, towards the centre the cells of the pith are thinner-walled, non-lignified and die away, so that the stem becomes hollow.

The Leaf: Any difference as regards anatomy could scarcely be demonstrated in the leaf-types of the different forms. Transverse sections, slightly magnified, of the leaf of var. *septentrionale* and of the principal form are shown in Fig. 13, *A* and *B*, the three main veins and the numerous fine anastomoses are seen.

The vascular bundle of the main veins has on its underside a covering of somewhat collenchymatously thickened elements; on the upper side the surface of the lamina dips down towards the vascular bundle. The structure of the mesophyll is fairly homogeneous, thus in Fig. 13, *F* it is hardly possible to demonstrate a palisade-layer; in specimens from Kola the uppermost layer of the mesophyll was however elongated in a somewhat palisade-like manner. Chlorophyll-grains occurred abundantly in the entire mesophyll, and besides this they were found in the epidermal cells of both surfaces.

The epidermal cells of the upper surface have from straight to slightly undulating lateral walls, those of the lower surface can be more strongly undulating. Both the outer and lateral walls of the epidermal cells are thin; the cuticle

of the outer walls is but slightly developed. Stomata occur in almost equal number on both sides of the leaf; the guard-cells are surrounded by 4—5 cells, and are on a level with, or slightly raised above, the surface of the lamina — on the large subtending leaves of the flowers I found them sometimes raised high above the surface.

The leaves are densely covered with hairs; the following types of hair occur: (1) Non-glandular, thin-walled, pointed and with fine cuticular striations; they may either be short (1—2 celled) or long (multicellular) and even elongated like a whip, the last-mentioned are numerous especially in var. *unalaschkensis*, and particularly in the top of the shoots. (2) Glandular hairs with multicellular stalk, and with 1—2 celled head; the basal cell has sometimes cuticular striations. (3) Glandular hairs with unicellular, quite short stalk and 2-celled head (in Fig. 13, *G* such a hair is seen in lateral view, highly magnified; in *H* and *I* they are seen from above), in the cells of the head and the stalk comparatively large nuclei occur, and a highly granular protoplasm. These various forms of hair occur intermixed (cf. Fig. 13, *F*, *H* and *I*); they are also found on the surface of the stem and, as already mentioned, in the floral region.

Euphrasia arctica Lange.

(*Euphrasia latifolia* (Pursh) Wettst.)

Alcohol material from West and East Greenland (Fredrikshaab, leg. Rosenvinge, 15. 8. 1886; Sydpröven; Hekla Havn, leg. N. Hartz, 13. 8; Unartok and Tasiusak).

Herbarium material from West and East Greenland, the shore of Hudson Bay, Northern Norway, *Lapponia murman.*

Lit.: Lange, 1880, p. 79; 1887, p. 264; Warming, 1886, pp. VII and 43; 1888, pp. 34 and 59; 1890, p. 226; Rosenvinge, 1892, p. 687; 1895 (I), p. 68; 1895 (II), pp. 162, 168, 219 and 245; Hartz, 1894,

pp. 9, 15, 20, 46 and 57; 1895 (I), pp. 146, 170, 179 and 289; 1895 (II), pp. 335, 359, 372 and 377; HARTZ and KRUUSE, 1911, pp. 359, 364, 409, 416, 423 and 428; WETTSTEIN, 1896, p. 136; ABROMEIT, 1899, p. 46; DUSÉN, 1901, p. 40; PORSILD, 1902, p. 197; 1912, pp. 382 and 387; 1920, p. 141; KRUUSE, 1905, p. 176; 1906, p. 250; 1911: in part IV, pp. 196, 229, 242, 247 and 261, and besides these many notes in the preceding parts; JØRGENSEN, 1919, p. 99.

As regards the Morphology, Biology and Anatomy of the *Euphrasia* spp. see: MÜLLER, 1881, p. 279; HOVELACQUE, 1888, pp. 400, 454 and 477; LINDMAN, 1887, p. 81; KOCH, 1895, pp. 140—144; WETTSTEIN, 1896; HEINRICHER, 1898 and 1902; KNUTH, 1899, pp. 202—206; and KERNER, 1900.

Nanophyllous therophyte; the seed germinates during early summer.

The main root is rather scantily branched; above the cotyledons there are 1—3 pairs of leaves separated by rather long internodes; "the first flowers generally occur in the axils of the 3rd or 4th pair of leaves, frequently in that of the 2nd pair, more rarely not until in that of the 5th, and as an exception, even in that of the 1st pair" (JÖRGENSEN). Towards the apex of the stem, the distance between the leaf-pairs becomes very short; the leaves become broader, and their teeth longer and more pointed than are those on the lower leaves of the stem; they all subtend flowers. The branching is, as a rule, scanty; sometimes a few weakly-developed branches are seen to proceed from the uppermost pair of leaves below the inflorescence; occasionally, however, branches, almost as vigorous as the main axis, may be developed from the axils of the two lowermost pairs of leaves — in this case it is evidently a matter of rather late-flowering individuals (August—September). Stem, leaves and calices are more or less densely covered with hairs.

"Die Pflanze variiert sehr viel, von sehr klein und einfach, mit wenigen Blüthen — so häufig an der Witterung

ausgesetzten alpinen Standorten — bis sehr gross, grob und verästelt mit sehr grossen und breiten, grobgezähnten Blättern, die bis über 2 cm lang und ebenso breit werden" (Jörgensen). Similar variations were found in the Greenland material. From the above-said it follows that the individuals generally agree in habit with the growth-type indicated by Wettstein as "frühblütige Form" (l. c. Fig. 1, p. 44); the comparatively short period of vegetation with which the individual may be compelled to be satisfied, in consequence of the geographical distribution of the species, makes, as Jörgensen (l. c. p. 104) remarks, this growth-type necessary in Arctic regions.

The flower-morphology and -biology of the *Euphrasia* spp. have been described so often that I can here confine myself to the following remarks: *E. arctica* belongs decidedly to the small-flowered forms; in no case did I find the corolla to be more than 7 mm in length, more frequently it was shorter. The flowers are protogynous, and in the recently expanded flower, the stigma generally stands somewhat in front of the anthers, afterwards the style curves downwards and backwards, so that the stigma is brought into close contact with the anthers which are now quite open (Warming, 1890). Sometimes, however, the stigma, even at the time when the flower is expanding, is so near to the anthers, that self-pollination must be able to take place easily; I even found pollen on the stigma of a not yet expanded flower.

Warming (1890, p. 227) mentions that a length-increment of the corolla-tube can take place — as in larger-flowered species —, by which the anthers are carried forward and approach the stigma; in some few of the flowers I did find the stigma protruding so far that a movement of this kind may very probably be of importance.

Geographical Distribution according to Jörgensen:

Greenland, Cumberland, Labrador, Iceland, the Færöes, Scotland, Sweden southwards to Herjedalen and Jämtland, Norway (common towards the north, rare south of the Trondhjem Fjord), Northern Finland and Russia, in Siberia at least as far towards the east as Jenisei. PORSILD (1912, p. 382) records the northern limit of the species in West Greenland to be Tartusaq (71°25′ N. lat.). In East Greenland *E. arctica* extends almost to 74° N. lat. (Lille-Pendulum Island: DUSÉN); from the district of Angmagsalik northwards it occurs most frequently, and grows more luxuriantly at the head of the fjords, whilst it is rarer and stunted in growth along the coast outside the fjords and on the islands off that coast.

The Habitat is given by the various authors in unison as being willow copses, heaths, grassy slopes and "herb-slopes"; ROSENVINGE (1896 (II), pp. 219 and 245) also found the species growing on gravelly flats (Igaliko) and on knolls in mossy bogs; HARTZ found it in the district of Scoresby Sound flowering as late as the middle of September. The fruit-setting appeared everywhere to be abundant and good.

The Anatomy of the root and the stem has been very exhaustively described by HOVELACQUE as regards "*E. officinalis*"; in *E. arctica* I found nothing which differed from his description.

The Root has only a few root-hairs; the cortex is thin and few-layered (3—4 cell-layers in thickness), its elements are greatly elongated in a tangential direction; in the endodermis the Casparian dots are distinct; in proportion to its diameter, the xylem part in the full-grown root forms a very thick bundle, composed of rather thin-walled vessels and wood-fibres.

The Stem has a rather thick-walled epidermis, upon which occur 2—3 celled, non-glandular hairs with fine cuti-

cular striations, and small glandular hairs with one-celled stalk and two-celled head. The cortex is few-layered (3—4 cell-layers in thickness) as in the root; in the endodermis the Casparian dots are faint, but nevertheless demonstrable

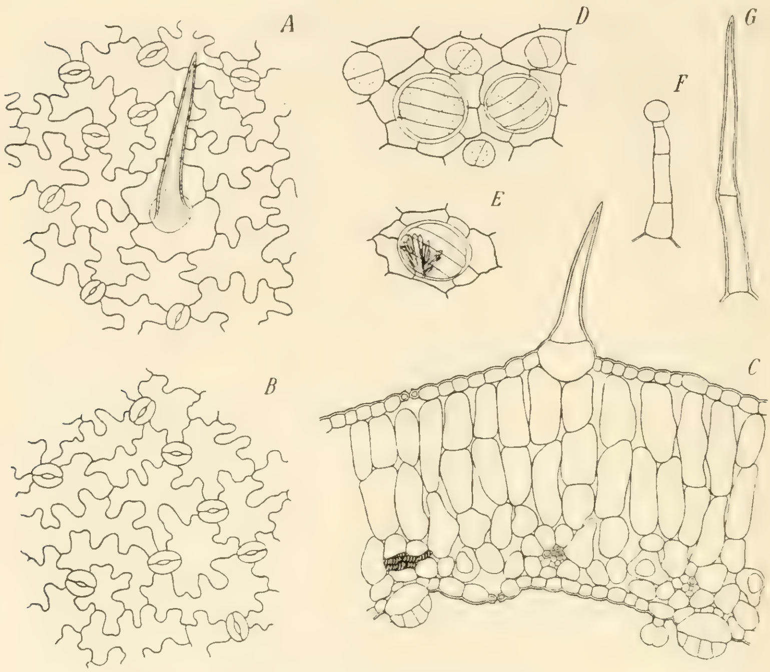


Fig. 14. *Euphrasia arctica.*
A, Epidermis of the upper, and *B* of the lower surface of the leaf. *C*, Transverse section of the leaf. *D* and *E*, Glandular hairs from the lower surface of the leaf. *F*, A glandular hair from the margin of the leaf. *G*, A 2-celled, non-glandular hair. (*A*, *B*, *C*, *D*, *E*, *F* and *G* about $^{110}/_{1}$). (Greenland.)

with Sudan III. The pericycle is 1—2 layered. The outer part of the rather broad ring of xylem is composed exclusively of wood-fibres. The peripheral cells of the pith have somewhat thickened walls. Medullary rays are absent.

The Leaf. A transverse section of one of the lower foliage-leaves is shown in Fig. 14, *C*; there occur 1—2 layers

of short palisade-cells, with rather large intercellular spaces; the spongy parenchyma consists of only slightly branched cells. The mesophyll of the upper leaves of the stem (i. e. the leaves subtending the flowers) appears, on the whole, to be more lacunose in structure than that illustrated in Fig. 14, *C*.

The margins of the teeth of the leaves are somewhat bent over, whereby a concavity is produced on their under side. In this concavity the leaf-surface is densely covered with glandular hairs, and the cells of the epidermis differ in character from the other epidermal cells of the leaf. For whilst these, both on the upper and lower surface — and especially on the upper side of the teeth of the leaves — have strongly undulating lateral walls (Fig. 14, *A* and *B*), which only here and there show a small flanged thickening, the epidermal cells in the concavities, and especially those which bear the glandular hairs, have straight or only slightly wavy lateral walls (Fig. 14, *D* and *E*), which are often (not, however, in the places illustrated in Fig. 14, *D*) furnished with flanged thickenings, the one by the side of the other. Stomata are almost equally abundant on both leaf-surfaces, in the concavities of the lower side of the teeth, however, they are less frequent; the guard-cells are on a level with the surface. In the teeth the veins break up into a fine network of tracheids.

The glandular hairs which occur on the lower side of the teeth are of two types: (1) a smaller one with one-celled stalk and two-celled, globular head, and (2) a larger one with two or more frequently four-celled cupola-shaped head, seated upon a short and broad stalk-cell which partly sinks below the leaf surface, the inner-wall of the stalk-cell, during the development of the hair, becoming rounded inwards, thus pressing the layer of epidermal cells, situated under the stalk-

cell, in the same direction (Fig. 14, *C*). The stalk-cell of the latter type of hair rests upon the connecting parts of 4—8 epidermal cells, which are produced by the division of a single cell, viz., the epidermal cell which has been the mother-cell of the glandular hair. Below the stalk-cell small, circular intercellular-spaces are formed between the lateral walls of the cells of the epidermal layer (cf. Fig. 14, *C* and *D*; in *D* that part of the lateral walls of the epidermal cells which lie under the stalk-cells, is indicated by dotted lines — the dotted circle inside the head of the small glandular hairs indicates the outline of the stalk-cell).

These large, peltate glands appear, therefore, to belong to the same type as the "Schilddrüsen" of *Lathraea* (and *Bartschia*), the development of which has been so thoroughly described by Scherffel; the intercellular spaces in the layer under the stalk-cell have not been perceived by Hovelacque or Wettstein.

The small glandular hairs belonging to type 1 are also found in other places on the leaf, but nowhere in such abundance, as in the concavities on the under surface of the teeth.

Glandular hairs with 1—2 celled head and multicellular stalk (Fig. 14, *F*), such as those required for the diagnosis of species, are found both along the margin of the leaf and also — but scantily — upon the lower surface.

Non-glandular hairs occur upon both leaf-surfaces, and are especially numerous towards the margin and on the veins; they are most frequently one-celled, but can also be 2—3 celled, pointed, and have fine cuticular striations (Fig. 14, *A*, *C* and *G*; *C* and *G* are seen in optical section; the thickness of the walls is evident from the figures). The epidermal cell or cells (2—4) which bear them are distinguished from the surrounding cells by having less strongly undulating lateral walls, and outer-walls which are more or less strongly arched outwards.

In the concavities on the under surface of the teeth I found the epidermis covered with crystal aggregates, which proved to consist of calcium-carbonate. — The same observation has been made by WETTSTEIN (l. c. p. 19). I have sometimes also found crystals of the said substance in the cells of the large glandular hairs, as shown in Fig. 14, *E*.

The palisade-tissue and spongy parenchyma were rich in chlorophyll-grains; and such were also found in the epidermis of the lower surface.

Bartschia alpina L.

Alcohol material from Norway (Aursundsöen, leg. TH. RESVOLL, 31. 8. 1918; Bosekop, Kaafjord, Alten, leg. E. WARMING, 11, 17. 8. 1885), Greenland (Sukkertoppen, 5. 7. 1884; Lyngmarken, leg. L. K. ROSENVINGE, 25. 7. 1886; Kangerdluarsuk, 5. 8. 1884 and 30. 7. 1885; Holsteinsborg, 15. 7. 1884; Sarfanguak, 15. 7), and Iceland (Gullfos and Tungafos, leg. A. FEDDERSEN, 25. 6. and 30. 6. 1886).

Herbarium material from Fennoscandia, Island of Kolgujew, the Færöes, Iceland, Greenland, the coast of Hudson Bay.

Lit.: AXELL, 1869, p. 102; LANGE, 1880, p. 78; 1887, p. 263; MÜLLER, 1881, p. 283; WARMING, 1886, pp. II, VI, 7 and 43; 1888, pp. 34, 39, 67, 75, 93 and 188; 1890, p. 226; LINDMAN, 1887, p. 82; HOVELACQUE, 1888, pp. 403, 451 and 478; ROSENVINGE, 1892, p. 687; 1896 (II), pp. 128, 144, 161, 165 and 168; HARTZ, 1894, pp. 9, 15, 27, 43, 57; 1895 (I), p. 302; 1895 (II), pp. 359, 372 and 392; JUNGNER, 1895, pp. 224 and 238; NORMAN, 1895, p. 455; ABROMEIT, 1899, p. 45; KNUTH, 1899, p. 197; KERNER, 1900, Bd. I, pp. 107, 129, 131 and 32, 173 and 606; Bd. II, pp. 116, 156, 251 and 301; CLEVE, 1901, pp. 8, 9, 23, 40, 57, 71, 76 and 89; Heinricher, III, 1901; PORSILD, 1902, pp. 181 and 194; 1912, p. 382, 387; 1920, p. 141; KRUUSE, 1905, p. 177; 1906, p. 249; 1911: in part IV, pp. 202, 229, 242, 244 and 254, and besides these numerous places in the preceding sections; SYLVÉN, 1906, p. 86; HOLLSTEIN, 1907, p. 126; SCHRÖTER, 1908, pp. 465—68 and 772.

A nanophyllous to microphyllous proto-hemicryptophyte with subterranean runners; the shoot-development usually extends over 2 years.

According to HEINRICHER and SYLVÉN the seed germinates in early summer. The first-named author, who has studied *Bartschia* very thoroughly, has pointed out that it belongs to the comparatively few plants which produce buds in the axils of the cotyledons. Whilst the uppermost part of the primary shoot dies away, the following year one of these buds develops into a foliage-leaf-bearing shoot, in the basal portion of which, small innovation-shoots arise, which, like their parent-shoot, will continue their growth in their second year, and become foliage-leaf-bearing shoots. As was the case with the primary shoot, the uppermost part of the axes of the succeeding shoot-generations dies down to above the innovation-shoots. Even after the 4th vegetative period, HEINRICHER's cultures did not yet bear flowers; the young plants had formed small sympodial, subterranean rhizomes, composed of the persistent, basal portions of the innovation-shoots.

HEINRICHER is of opinion that, in Nature, the first vegetative-stage is of 4—5 years duration.

With regard to the morphology of the full-grown plant, in the following description the statements given in the cited work of HEINRICHER will be found verified; for criticism of preceding investigations (HOVELACQUE, KERNER), reference may be made to the same author.

Fig. 15, *A* and *D* show the structure of the shoot, and the mode of branching. In Fig. 15, *A*, each of the two shoots, II^1 and II^2, had terminated in an inflorescence. The shoots are in their 2nd year of development; during the first year each of them had developed a subterranean portion, bearing decussated scale-leaves which have now withered; the uppermost pairs of these scale-leaves has served as bud-scales for the winter-buds. The first year's growth-increment especially of II^1 is seen to have the character of a runner, the growth-

direction has been horizontal, and the distance between the nodes is comparatively considerable. The apex of such a runner is shown in Fig. 15, *C*. In Fig. 15, *D*, III^2 has not borne flowers; the sister-shoot III^1 has been arrested in its



Fig. 15. *Bartschia alpina.*
A, The lower portion of a flowering plant; both II^1 and II^2 have borne inflorescences (Holsteinsborg, 5. 7. 1884). *B*, A foliage-leaf. *C*, The apex of a runner. *D*, Portion of a sympodium in which the runner-like portion of shoot *II* is particularly long; *r* is an adventitious root. (*C* and *D*, Aursundsöen, 31. 8. 1918.) (About $^4/_3$.)

development, the two small basal pairs of leaves are from the previous year, and withered, but the bud is in a fresh condition; like shoot *II* shoot *I* has had a long runner-like portion. The innovation-shoots are always developed from the portion of the shoot of the first year; in case the latter

shoot is elongated in a runner-like manner, the new shoots generally appear near the spot where it begins to bend upwards, but if it is short and vertical, the new shoots most frequently appear at the base — sometimes, however, also higher up; as an exception, shoots ("enriching-shoots") may appear in the axils of the lowermost foliage-leaves: such shoots, however, will probably be always purely vegetative and terminate their development in the same year as the parent-shoot. After flowering and fruit-setting, the latter shoot dies down to immediately above the innovation-shoots.

Innovation-shoots are generally developed to the number of two on the parent-shoots; II^1 and II^2 in A and III^1 and III^2 in D are seen to have arisen in the axils of two opposite scale-leaves; this is most frequently the case, and explains the fact why two flower-bearing axes are frequently found to stand together. In Fig. 15, D a non-expanded bud is seen in the axil of the first scale-leaf to the right of the subtending leaves of the innovation-shoots.

The innovation-shoots are developed rather late in the Arctic summer; in the abundant herbarium-material from Greenland which I have at my disposal I never found the young shoots to be visible in individuals collected in June—July, whereas in those collected in August they were about one centimetre long.

This does not quite agree with the statement of HEINRICHER, according to which they already expand simultaneously with the foliage-leaves of the mother-shoot. The difference may perhaps be explained by the more unfavourable conditions of growth, presented by the Arctic summer, in which the building-up of new organs can be compelled to extend over a longer space of time.

The same author states, that small buds for the innovation-shoots are already to be found the year previous to

that, in which they expand; the same is the case with the buds for the flowers.

As already mentioned, the portion of the shoot developed during the first year of growth, may either have elongated internodes and be runner-like, or — as e. g. figured by Kerner on p. 129 (l. c.) — it may have quite short internodes with close-set scale-leaves; the first 2—3 internodes of the stem are, however, generally somewhat longer than those following; and here the scale-leaves are smaller. If by means of the latter form of shoots the ramification should be continued through several shoot-generations, the individual becomes gradually cæspitose in habit. A tuft of this kind collected by M. Porsild in West Greenland ("heathy slopes") had about 50 older and withered shoots, and some 20 fresh ones — both vegetative and flowering. The individual had sometimes formed quite short runners, adventitious roots were scantily developed, and the entire system was borne by a single root (whether main root or adventitious root was not clear) about 5 mm thick.

The adventitious roots spring — often abundantly — from the nodes.

The rhizome, probably as a rule, dies away rather quickly from behind; however, in a specimen from East Greenland with cæspitose habit, a part of it had attained a thickness of fully 5 mm, and the whole system was evidently old.

The plants are densely covered with hairs especially at the top; hairs (non-glandular) also occur on the subterranean portions of the shoots, Kerner ascribes importance to these hairs as organs of absorption; according to Heinricher, however, there is no reason to assume that they have such a function.

The Flower-biology has been dealt with by H. Müller, E. Warming, Lindman, Kerner and others. The accompa-

nying figures are borrowed from Warming, 1886, and the following is cited from his description: "The Scandinavian and Greenland individuals of this species appear to me to be exactly alike in every way, but differ from those of the Alps in at least one respect, that is, provided that H. Müller has informed us of all the forms occurring there. Fig. 16 shows

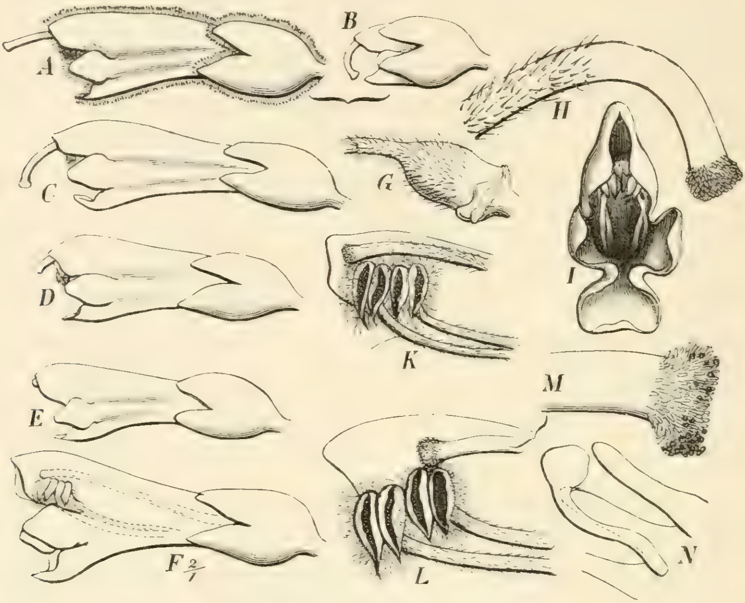


Fig. 16. *Bartschia alpina.*
A and *B* from East Greenland (Eberlin, 30. 7. 1885); *C* from Kaafjord near Alten in West Finmark; *D* from Godthaab in West Greenland (28. 6. 1884); all the anthers were open, and pollen had already germinated upon the stigma. *E* and *F* are from Holsteinsborg in West Greenland (15. 7. 1884). *A*—*F* are twice the natural size; the others, which are all drawn from Greenland material, are in various magnifications. For further particulars see text (Warming, 1886).

the structure of this flower, partly from Norwegian and partly from Greenland material (in the majority of cases the hair-covering has been omitted or only indicated along the outlines of the figures). The conspicuousness of the dull purple-violet

corolla, which like the calyx, is densely covered with glandular hairs, is increased by the fact that the subtending bracts are also of a dull violet. I have not noticed any scent, but honey is secreted by the greenish nectary on the front of the ovary (Fig. 16, *G*). Müller has described how humble-bees and other insects, by thrusting their proboscis and also their heads into the flower (see Fig. *I*, the corolla seen from the front) strike against the pointed lower ends of the anthers (Fig. 16, *K* and *L*), whereby the anthers which adhere by their hairs, are violently torn from one another, by which means the dry and light pollen-grains are scattered and fall upon the insect, which then easily conveys them to another flower and deposits them upon the stigma (Fig. 16, *A*—*E*, *M*) which protrudes even in the bud (Fig. 16, *B*). Specimens with flowers, the structure of which is exactly like that of the flowers of the Alps, have also been found to occur both in Norway and in Greenland[1], these specimens have evidently marked insect-visited flowers which either cannot pollinate themselves, or can only do so with great difficulty. My figures (which have all been drawn from full-grown flowers) show that both the length of the style and the size of the whole flower vary considerably, apart from the difference of age. Thus specimens are found which have so short a style throughout their whole life, that the stigma does not become visible outside the corolla; in some, however, the stigma is situated immediately inside the throat of the flower (Fig. 16, *F*, *K*), but in others it lies even as far inside as above the hindmost anthers (Fig. 16, *L*). In these cases the stigma lies against the anthers, and self-pollination, as far as I can see, is inevitable; and in such flowers I have also distinctly seen

[1] Müller does not mention that the style is beset with stiff hairs directed forwards, except at its uppermost end (Fig. 16, *H*); but it is probable that it has this feature also in the Alps.

pollen-grains deposited especially upon the lower part of the stigma — the part which is in contact with the anthers (Fig. 16, *M*). For the rest, the pollen-grains fall out very easily, and it is very common for masses of pollen-grains to be found scattered everywhere in the flower: on the corolla, the filaments, the style, etc. Even if the stigma ripens shortly before the anthers — which I found to be the case in the district of Holsteinsborg — the two organs nevertheless very soon become simultaneously functional and this throughout the greater part of the life of the plant, so that self-pollination is possible. That *Bartschia*, in many places in Greenland, produces ripe fruit, I saw in 1884, from the fragments of such fruit which had remained over from the preceding year."

According to Kerner (II, p. 301) wind-pollination takes place regularly in *Bartschia*, in a similar manner as for instance in *Lathræa*, at the end of the flowering period: the style in the older flower withers, the filaments are elongated and carry the anthers outwards, the latter separate and pollen, which may have been left in the anthers is scattered by the agency of the wind, and may pollinate the younger (upper) flowers of the inflorescence. This probably explains the fact mentioned by Lindman that the anthers may project beyond the edge of the corolla. This author also mentions the same variations in the length of the style as those of which Warming speaks.

Also in the material at my disposal there were flowers in which the anthers protruded, and it was generally the lowermost (oldest) flowers of the inflorescence in which this was the case.

Aug. Schulz differs from Warming in finding that in the Riesengebirge (Bibl. bot. No. 10, 1888, p. 74 — here cited from Knuth) the length of the style, in relation to the corolla,

differs in older and younger flowers, so that the style of the younger flower protrudes farther than that of the older, the corolla-tube of the latter having increased in length. The elongation may be as much as 5 mm and bring the anthers — the filaments follow the corolla in growth — into contact with the stigma, so that self-pollination takes place. Warming (1890, p. 226) admits that such a growth can take place, and disturb the relations of the organs in question, but maintains that individual differences also occur in the relative length of the style and the corolla. I found the same forms that have been illustrated by Warming (1886) in his Fig. 3, *A—F*, *K* and *L* (reproduced in this paper as Fig. 16), and even if there might possibly occur some difference in the length of the corolla of older and of younger flowers of the same inflorescence, yet I never found the style protruded far in the young flowers and enclosed in the older ones; that, at any rate under more northerly latitudes, it is really a matter of individual differences, is supported by a statement of Mr. Nyhuus of Tromsö, who in a letter to E. Warming in 1885 writes: "On Aug. 24th I found *Bartsia* there (i. e. Dalfjæld in Marknæsdalen) in abundance (towards the south) from a height of 2500 feet and down over the whole mountain; but from about 2500 to 1500 feet I did not find a single flower with protruding style although I can truthfully say that I examined several hundred plants. On the other hand, lower than that, long-styled flowers became constantly more frequent" (E. Warming, 1886, p. 10).

I found the fruit-setting to be good and abundant everywhere. "Die geflügelten Samen werden durch den Wind verbreitet." (Schröter).

Geographical distribution in the Arctics according to Lange and Porsild: Labrador, Arctic Russia and Siberia, (according to F. R. Kjellman's lists of the flora, in Siberia

it does not seem, however, to occur at or near the coast), Scandinavia, Iceland, the Færöes and Great Britain, in addition, the species extends over "ein mittel-europäisches Gebirgsareal von den Pyrenäen bis zum Balkan mit Vorstössen zu den deutschen Mittelgebirgen und zahlreichen Standorten im Vorland" (SCHRÖTER). In West Greenland its northern limit is the Ignerit Fjord (Umanak), in East Greenland it does not reach so far as to the region of Scoresby Sound. KRUUSE (1905, p. 177) states that the northern limit there is at 68° 8′ N. lat.

Habitat. According to WARMING in West Greenland it grows in willow-copses and on "herb-flats"; in the most southerly West Greenland ROSENVINGE found it in willow and birch copses, on "herb-slopes" and grassy slopes.

As regards the conditions pertaining to the growth of *Bartschia* in East Greenland KRUUSE (1905, p. 177) writes: "it is very rare north of 66° 20′ and only 10 cm. high, but yet it sets flower everywhere and as far as can be judged from the collected material also fruit. It shuns here the coast, and all finding places are well sheltered, exposed to the south and have the character of herby slopes, while the species more to the south prefers heath", and in the Angmagsalik district it is (1906, p. 249) "commonly distributed on herby slopes and in fertile heath".

NORMAN records it from Northern Norway as growing "in bogs, on damp cliffs, in birch-woods, on flats at the riverbanks and on the beach, as an exception below the uppermost belt of sea-weeds; it occurs chiefly on the sunny sides, somewhat more seldom on the indifferent (eastern and western) sides and as an exception on the shady sides". A. CLEVE records that on the mountains in the north of Sweden it is "Ein sparsamer, exclusiver Bewohner der trockenen Blütenwiese mit vollen S-Exposition . . . Ein typischer hydrophyt

der Weiden- und Waldregionen Lapplands, kann aber diese Art im Hochgebirge sich nur an den viel Wärme darbietenden Stellen behaupten, mögen letztere auch viel trockenen sein, als es gewöhnlich in dem Tieflande der Fall ist."

In the Alps it grows on "alle Formen alp. Wiesen und den Quellfluren von den Vorbergen bis gegen die Nivalregion (SCHRÖTER)".

In the Arctics *Bartschia* belongs to the group of plants of later summer, which is easily understood when one considers the considerable vegetative work the shoots must carry out, before flowering can take place.

Anatomy. The Root. An adventitious root, about 1 mm thick, showed the following structure: The epidermis had died away, only here and there a few of its cells remained in a collapsed condition. The outermost layer of the primary cortex had cuticularized cell-walls; in many of its cells a division had taken place during growth, and in these cells one very thin, non-cuticularised radial wall was found. The cells in the inner layers of the cortex were distinctly tangentially elongated and were likewise divided secondarily by thin radial walls — in the cells of the endodermis as many as four such walls were found. The wall of each of the original endodermal cells is in its whole circumference furnished with a cuticularized layer, but as in the exodermis, the thin radial walls which had developed later, were not cuticularised here either. The root was 3-rayed; in transverse section the xylem-part now formed a circular bundle, consisting of vessels and wood-fibres, since the cambium had commenced its activity all the way round. The epidermis evidently dies away very early; even in a root hardly 0.5 mm in thickness, the epidermal cells were found in a collapsed condition.

The root of 5 millimetres thickness, with which the individual from West Greenland, mentioned above, was fur-

nished, had a xylem-cylinder, 3 mm thick, which consisted for the most part of vessels, thin-walled and rather wide; in addition thin-walled wood-fibres occurred.

Parenchyma rays did not occur, neither were there any indication of growth-zones. In the secondary cortex sieve-tubes were rather scantily present. Cork was not developed. In the roots both the endodermal and the exordermal cells were full of a brown substance.

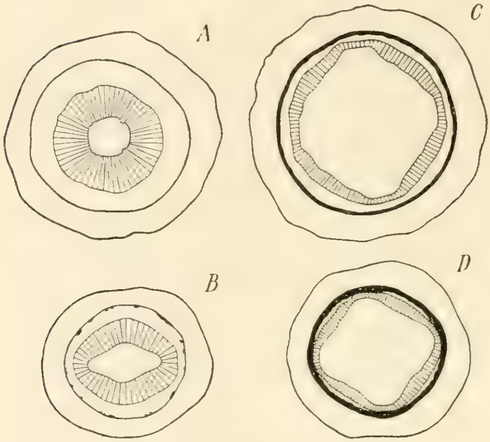


Fig. 17. *Bartschia alpina.*
Diagrammatic transverse sections of the stem: *A* and *B*, from runners; *C*, from the aerial stem taken between the 3rd and 4th pair of foliage-leaves; *D*, taken at the point of transition between rhizome and the aerial stem (the black ring in *C* and *D* is the hard-bast, whilst the wood-ring in all the figures is radially shaded). (About $^{18}/_{1}$.)

The Stem. In HOVELAQUE's work it is particularly the anatomy of the stem which has been exhaustively treated, and *Bartschia* has, on this point, since been again investigated by HOLLSTEIN. To this I have nothing new to add, and can therefore confine myself to the following brief description.

A section taken from a little above the middle of the foliage-leaf-bearing part of the stem (a diagrammatic representation is given in Fig. 17, *C*) shows a thin-walled epidermis, beneath which there is a cortex, the outermost layer of which has somewhat thickened cell-walls; several of the cortical cells have undergone division by means of thin radial

walls. In the endodermis — contrary to Hovelaque, who mentions its cells as being "sans cadres" — I found distinct, although rather faint, Casparian dots. The outermost layers of the stele consist here of rather thin-walled lignified prosenchymatous cells; the sieve-tissue forms a continuous ring outside the xylem-part, which in the whole extent of its periphery consists almost exclusively of wood-fibres. The pith consists of thin-walled cells which collapse early in the centre of the stem.

A section taken at about the middle of the subterranean part of the axis, is distinguished from the above by having a more distinct endodermis, the cells of which have, as in the root, a suberised lamella in the whole circumference of the wall — the contents of the endodermal cells have a brown colour —, by entirely wanting hard bast, or at any rate, by having it only in a far more slightly developed degree (in the two diagrammatic figures, Fig. 17, *A* and *B*, the line between the outer edge of the xylem-ring and the periphery is the endodermis, the black dots within this, in Fig. *B*, are small groups of hard-bast cells — in *A* these are totally wanting), and lastly, by a comparatively narrower pith and broader xylem-ring, in which wood-fibres are less numerous and thin-walled.

At the point of transition between rhizome and the aërial stem, the hard-bast appears successively (the cells of the hard-bast are here somewhat more thick-walled than at the top of the shoot), the pith widens, the xylem-ring becomes thinner and richer in wood-fibres throughout its periphery. The sieve-tissue is divided into four larger groups, since the hard bast and the wood-fibres of the xylem-ring at four points which decussate, tend to approach one another, and may practically coalesce at these points (this phenomenon is connected with the passing-out of the leaf-trace-bundles

from the stele, compare Fig. 17, *D*, which is a diagrammatic representation of a part like the one just described — the section was taken between the uppermost scale-leaf and the first pair of foliage-leaves), small groups of sieve-tissue

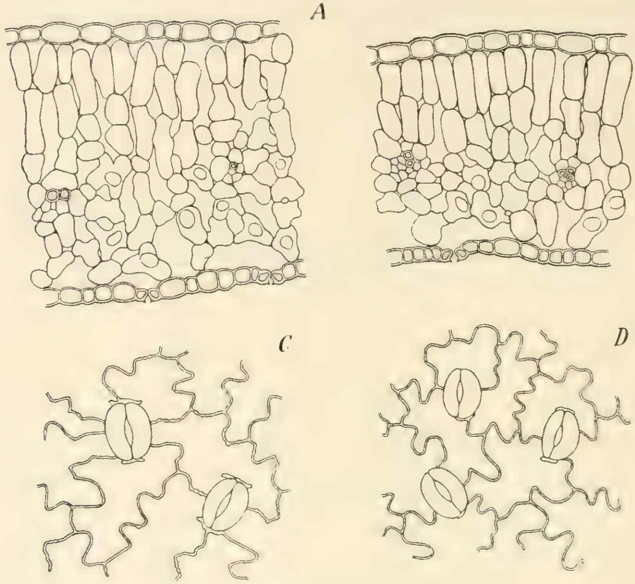


Fig. 18. *Bartschia alpina.*
A and *B*, Transverse sections of foliage-leaves. *C* and *D*, Portions of the epidermis of the upper and of the lower surface respectively. (West Greenland.) (*A* and *B*, about $^{140}/_1$; *C* and *D*, about $^{220}/_1$.)

elements, however, are always found enclosed in the stereom (well-illustrated in HOVELAQUE's Fig. 334, p. 405).

Medullary rays do not occur. The epidermis of the rhizome persists for a long time; cork is not developed (HOLLSTEIN); in the older rhizomes a successive dying-away of the outer layers of the cortex takes place.

The Leaf. The epidermal cells of both the upper and the lower surface have undulating lateral walls, this being somewhat more strongly the case with those of the lower surface than with those of the upper (Fig. 18, *C* and *D*).

Stomata occur on both leaf-surfaces, but they are more numerous on the lower surface; the proportion between the number of stomata on both surfaces proved to be about 1 to 2. On the upper surface the lateral walls of the epidermal cells are slightly porose, especially near stomata; the guard-cells are surrounded by 3—6 cells, and are on a level with the surface, or project slightly (Fig. 18, *A* and *B*).

The transverse section (Fig. 18, *A* and *B*) shows 1—3 palisade-layers. Both *A* and *B* were drawn from sections of leaves taken from specimens from West Greenland, and in both cases the leaves were chosen from the middle of the stem. *A* is seen to be somewhat thicker than *B*, and to have an assimilatory tissue consisting of as many as 3 cell-layers, the elements of this tissue are somewhat irregular and some of them are slightly branched; *B* probably represents the more common type. The transverse section of the leaves of the Norwegian plants resembles, on the whole, the transverse section shown in *B*, with the exception that the palisade-cells are slightly higher. The spongy parenchyma consists of rather copiously-branched cells. In the palisade-tissue and spongy parenchyma chlorophyll-grains are present in abundance.

The leaves are rather densely covered with hairs; the following types of hair occur: —

(1) Non-glandular hairs, with one or many cells, thin-walled, glabrous and pointed (Fig. 19, *C* and *E*); (2) Glandular hairs with longer, two- or many-celled stalk and a 2—4 celled head (Fig. 19, *A*, *B* and *D*); (3) Glandular hairs with short, one-celled stalk and 2 or commonly 4-celled head (Fig. 19, *F*); (4) Glandular hairs of the kind illustrated in Fig. 19, *G*, *H*, *I* and *K* with a low somewhat sunken stalk-cell, and a cupola-like extremely thin-walled 4-celled head.

By comparision of the figures in question with Fig. 14

C, *D* and *E*, it becomes evident, that this form of glands in *Bartschia* — as already pointed out by Heinricher (cf. his addition to the cited paper of Scherffel) — belongs to the *Lathraea*-type like the similar ones in *Euphrasia*. Fig. 19, *I* and *K* show these glandular hairs seen from above;

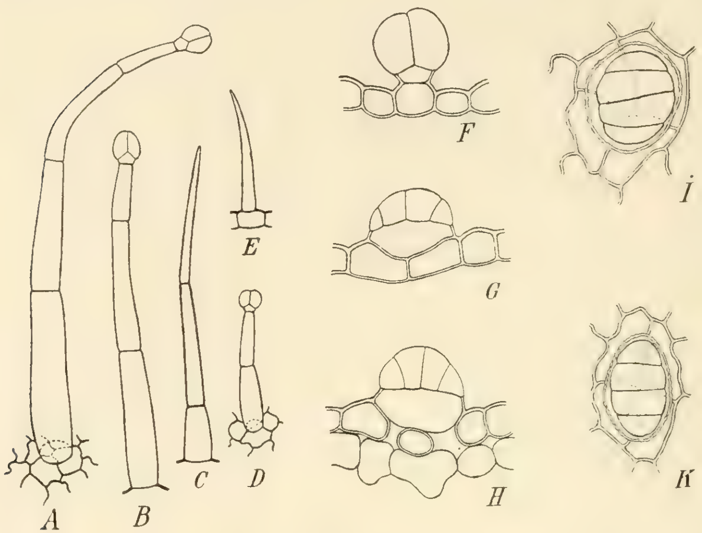


Fig. 19. *Bartschia alpina.*
Different types of non-glandular and glandular hairs from the leaf. (*A—E*, about $^{90}/_{1}$; *F—K*, about $^{290}/_{1}$.)

below the stalk-cell the lateral walls of the epidermal cells are indicated by dots, in *K* two intercellular spaces are formed between them, 2—4 of these are found rather commonly under the hairs. A glandular hair, similar to that which is seen from above in *K*, is shown in *H* in transverse section, here also 2 intercellular spaces are distinctly seen. *G* and *I* have no intercellular spaces of this kind. Glandular hairs of type 4 occur only on the lower surface of the leaf, under the branches of the veins of higher order; in the same place there is found in addition to this a great number of hair

of type 3, but the latter kind of hair is also found on the upper surface of the leaf, located at the margin of the leaf in the innermost part of its indentations, i. e. above the extreme points of the veins (cf. Fig. 15, *B*). The non-glandular hairs and the long-stalked glandular hairs occur on both leaf-surfaces, and they grow most densely near or upon the veins.

Upon the scale-leaves at the base of the shoots glandular hairs of the type shown in Fig. 19, *F* predominate, they are especially numerous on the lower surface, where the majority of them are found arranged in two broad stripes, one along each of the margins of the leaf; mingled with them are found glandular hairs of type 4.

The stems are covered with multicellular non-glandular hairs, and glandular hairs which frequently have multicellular stalks.

Pedicularis lapponica L.

Alcohol-material from Norway (Aursunden, leg. Th. R. Resvoll, 8. 8. 1918; Skådavara in West Finmark, leg. E. Warming, 7. 7. 1885).

Herbarium-material from West and East Greenland, *Lapponia murmanica*, Nova Zembla, Labrador, Arctic Siberia and the coast of Hudson Bay.

Lit.: Axell, 1869, p. 102; Lange, 1871, pp. 256 and 265, tab. III, fig. 16 (the seed); 1880, p. 74; 1887, p. 262; Warming, 1886, pp. 44 and 47; 1888, pp. 35, 39, 59 and 87; 1890, pp. 207, 208, 210, 211 and 219; Lindman, 1887, p. 84; Rosenvinge, 1892, p. 686; 1896 (I), p. 68; 1896 (II), p. 78; Hartz, 1894, pp. 37 and 39; 1895 (I), pp. 137, 175, 219, 271 and 288; 1895 (II), pp. 335, 359 and 372; Hartz and Kruuse, 1911, pp. 347, 359, 365, 388, 409, 419, 423 and 428; Ekstam, 1897, pp. 119, 167 and 168; Kruuse, 1898, pp. 373, 380 and 394; 1905, p. 175; Abromeit, 1899, p. 42; Knuth, 1899, p. 190; Dusén, 1901, p. 39; Norman, 1901, p. 457; Cleve, 1901, pp. 9, 39, 57, 70, 71, 76 and 89; Skottsberg, 1901, p. 8; Porsild, 1902, pp. 114, 167, 175 and 187; 1910, pp. 267 and 271; 1912, pp. 382 and 387; 1920,

p. 142; POPPIUS, 1903, p. 48; SYLVÉN, 1905, p. 88; SILÉN, 1906, p. 92; SIMMONS, 1906, p. 34.

Hemicrytophyte, with a primary root which dies away rather quickly; it spreads by means of slender, subterranean runners. As a rule, these are monopodial: their short vertical portion bears leaf-rosettes, usually through a limited number of growth-periods (1—3), the floral shoots arising as lateral axes on the rosette-axis.

As shown in Fig. 20, *A* and *B* the horizontal portion of the runners has elongated internodes, with small scale-leaves; in the axils of these, buds are formed which grow out into new runners. New runners arise only in the horizontal portion of the parent-shoot. The runners are provided with adventitious roots, which must be described as "restricted to one position only", inasmuch as they arise in connection with the axils of the scale-leaves, as a rule one at each. Haustoria were found on the roots.

When the runner bends upwards, its internodes become short, and the scale-leaves pass without intermediate forms, into long-stalked foliage-leaves, of which it bears 3—7 in the first year (at x in Fig. 20, *A* and *B* the dead stalks of the rosette-leaves of the previous year are seen); at the end of the season of growth a number of scale-leaves are again formed, which function as bud-scales for the winter-bud. Some runners pass over directly into their winter-rest, without having succeeded in forming leaf-rosettes in the first year.

Both the scale-leaves under the rosettes, and the rosette-leaves, as well as the scales of the winter-bud, can subtend buds (Fig. 20, *A*, *B* and *D*); the lowermost buds must probably be regarded as reserve-buds; any true principal bud does not occur.

At the beginning of the next season of growth, one or several — as many as 3 — of the buds can grow out into



Fig. 20. *Pedicularis lapponica.*

A, A part of a flowering plant. On the runner two new runners (*a* and *b*) have developed as lateral shoots, and an erect, floral shoot, of which only the lower half has been figured; *r*, adventitious roots. The uppermost of the two buds seen just below the floral shoot is the terminal bud of the runner. The runner *a* is in its second year of growth; the withered remains of the rosette-leaves (*x*) of the previous year are seen under the scales of the winter-bud. *B*, The apex of a runner; under the leaf-rosette one sees the scales of the winter-bud, — which scales subtend small buds, — and the withered remains of the foliage-leaves (*x*) of the previous year; a floral lateral shoot has been developed. *C* and *D*, Apices of two runners; *C* with dead, terminal bud

and two lateral shoots (floral), *D* with a floral lateral shoot and four reserve-buds. *E*, One of the leaves of a floral shoot. (*A* and *E*, Greenland.) *A* and *B* about nat. size; *C* and *D* about $^4/_3$; *E* about $^3/_1$. (*B*, *C* and *D* are drawn from sketches by E. WARMING.)

floral shoots; as shown in the figures, they bear scale-leaves (*ex parte* bud-scales) at their base; these pass gradually into foliage-leaves in the middle of the shoot. The foliage-leaves of the floral axes differ somewhat in form from the rosette-leaves; the midrib is broader, and the incisions of the margin are less deep (Fig. 20, *E*). The inflorescence is a crowded, almost capitulate raceme, without a terminal flower; according to WARMING, the flowers in the middle of the inflorescence, are the first to expand. The terminal bud of the runner, as a rule, continues its growth by forming a second leaf-rosette; exceptionally, it may produce a floral shoot, which consequently becomes terminal; the latter has only scale-leaves at its base. In addition I must remark, that in a single case, I found a runner which, without a previous vegetative-stage (leaf-rosette), terminated directly in an inflorescence.

A runner hardly ever forms leaf-rosettes for more than 3 successive growth-periods. Also in the axils of the scale-leaves of the floral shoots buds occur; in cases in which these develop further, they frequently form, in the following year, shoots of similar structure to the parent-shoot. WARMING mentions that at the base of the floral shoots also, rosettes of foliage-leaves may be produced; in some cases I succeeded in demonstrating such leaf-rosettes, but they are evidently of rare occurrence.

The structure and biology of the flower are explained by LINDMAN and E. WARMING, of whose descriptions the following is an extract: The lower lip of the almost horizontally projecting flower incline very decidedly to the right

(seen from the front); besides this, the whole flower is subject to torsion around its axis to the right; this causes the upper lip to slope even more to the right, while its helmet-shaped apex, and the part of the style turned downwards, point to the left; the lower lip stands almost in the vertical plane (LINDMAN, p. 84, Pl. IV, fig. 47, *A* and *B*).

"The calyx is dark-red, the corolla pale yellow or brimstone-coloured. On the lower lip there are two conspicuous convexities covered with hairs, the corolla-tube is 6—8 mm long" . . . "The slit of the upper lip is about 1—$1^1/_2$ mm wide; the front stamens are slightly hairy or glabrous. The style may be enclosed (and this is the case at the same time as the anthers are open), but usually it protrudes more or less, from 1.5 to 2.5 mm or even more (without being moved away from its natural position up to the dorsal side of the upper lip). Even in the bud it protrudes somewhat, so that the stigma comes into contact with the lower lip; the former is even at that time papillose, and appears ripe, consequently, slight protogyny appears to prevail. Afterwards the anthers are seen to have dehisced, without the length of the style having altered; consequently, self-pollination appears to be able to take place, but not easily, because although it is true that the anthers come to stand vertically above the stigma, yet the distance between them is comparatively great". (WARMING, p. 219, fig. 33, reproduced here as Fig. 21).

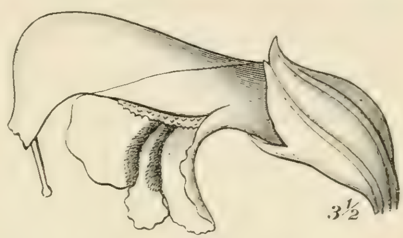


Fig. 21. *Pedicularis lapponica.* A flower with a far-protruding style. (Greenland, about 67° N. lat.) (E. WARMING, 1890.)

All authors join in attributing perfume to the flowers of *P. lapponica*; LINDMAN mentions its "strong perfume",

and Hartz (1895 (I), p. 271) writes, that *P. lapponica* and *Viscaria* filled the air with perfume (East Greenland, 7. 7. 92).

Pollination takes place by the agency of humble-bees, which, according to Lindman, alight on the upwardly turned, left side of the lower lip; the stigma is consequently, by the torsion described above, turned towards the visitor. According to the same author, the humble-bee thrusts its proboscis into the flower, at the widest part of the slit of the upper lip, at about the middle of it, just above the revolute portion of the edge of the upper lip, but not into the narrow groove between the two convexities of the lower lip.

Several of the specimens from West Greenland had one-year-old fruits, from East Greenland I saw fruit-bearing specimens from Danmarks Ø (N. Hartz leg.).

According to Porsild (*in litt.*) visits of humble-bees are rare, and fruit-setting (in contradistinction to the other *Pedicularis* spp.) is generally not good; many of the capsules are empty, and in others only a few seeds are found. Ekstam's observations from Nova Zembla agree with those of Porsild.

A description and beautiful illustration (Pl. III, Fig. 16) of the seed is found in Lange, 1870.

P. Lapponica is a decidedly middle-summer-flowering species.

Geographical Distribution: Greenland, Arctic America, Labrador, Kamschatka, Arctic Siberia, Nova Zembla, Arctic Russia, Scandinavia and Lapland. Rosenvinge (1892) records, that in West Greenland it is rather common north of 64° N. lat., but very rare south of this. "The northern limit in West Greenland is still unknown, in the fjords at 72°23′ it was so commonly distributed that the northern limit hardly can be here" (Porsild, 1920). In East Greenland the species is only found between 69°25′ and 73°10′ N. lat. (Kruuse, 1905, p. 175).

Habitat: In Greenland it grows in mossy bogs, and in damp places on heaths; the runners creep in the moss, or in slightly decomposed vegetable matter (M. Porsild, *in litt.*); it is "covered by thick layers of snow during winter" (Porsild, 1920). Warming, 1888, mentions it as inhabiting willow copses, herb-slopes and heaths. On Nova Zembla Ekstam found it growing in dry localities, which were exposed to strong insolation. A. Cleve finds it on mountain heights in Lule Lappmark, avoiding wet ground and the poorest heath; she writes: "Sie gedeiht am besten in den Waldregionen und sucht im Hochgebirge relativ trockene Standorte auf, was schon Wahlenberg aufgefallen war."

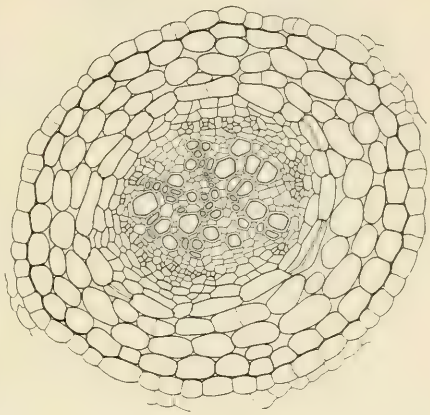


Fig. 22. *Pedicularis lapponica.* Transverse section of an adventitious root (about $^{110}/_{1}$).

Anatomy. The Root: The structure is shown in the transverse section figured in Fig. 22. The secondary growth is not considerable, and does not greatly exceed what is shown in the figure in question. The endodermis is a very beautifully developed Casparian sheath. The epidermis dies away quickly; the outer walls of the exodermis were found to be cuticularised. On the surface of the roots, dark-coloured, fungal hyphæ were frequently found.

The Stem: (1) Runners: The epidermal cells have fairly thick outer walls; they are filled with a homogeneous brown mass, which gave the reaction of tannin. The outermost cortical layer adjoins the epidermis without inter-

cellular spaces; the cells of the cortex show radial divisions by thin walls of secondary formation. The endodermis is exactly as in the root. The pericycle is 4—7 layered, its cells, like those of the cortex, have somewhat thickened walls. The wood-cylinder is continuous, without parenchyma-rays, but is often somewhat excentrically developed, so that the wood on that side of the shoots which is turned down-

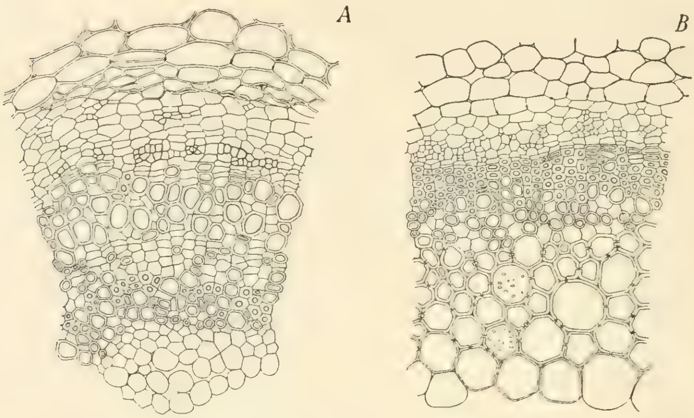


Fig. 23. *Pedicularis lapponica.*
A, Portion of transverse section of runner. *B*, Portion of transverse section of flower-bearing stem. (Greenland.) (About $^{140}/_{1}$.)

wards, is thinner than on the upturned side. As shown in Fig. 23, *A*, annual rings can be formed in the runners. The two annual rings are separated by thin-walled parenchyma, mixed with small vessels, and the vessels are much larger in the second than in the first annual ring. Some stereom (wood-fibres) is seen, especially in the inner annual ring.

(2) The Flower-bearing stem (Fig. 23, *B*) differs from the runners in that the cells of its cortex and of its only 1—2 layered pericycle, are much thinner-walled than in the runners, moreover, by the Casparian spots in the endodermis being much fainter, by the narrower vessels of the xylem-

ring, and the almost continuous ring of wood-fibres on the outer side of the latter, and by the outer layers of cells of the pith being thickened and lignified. The central part of the pith has died away, and the stem is consequently hollow. Stomata occur in the thick-walled epidermis, and chloro-

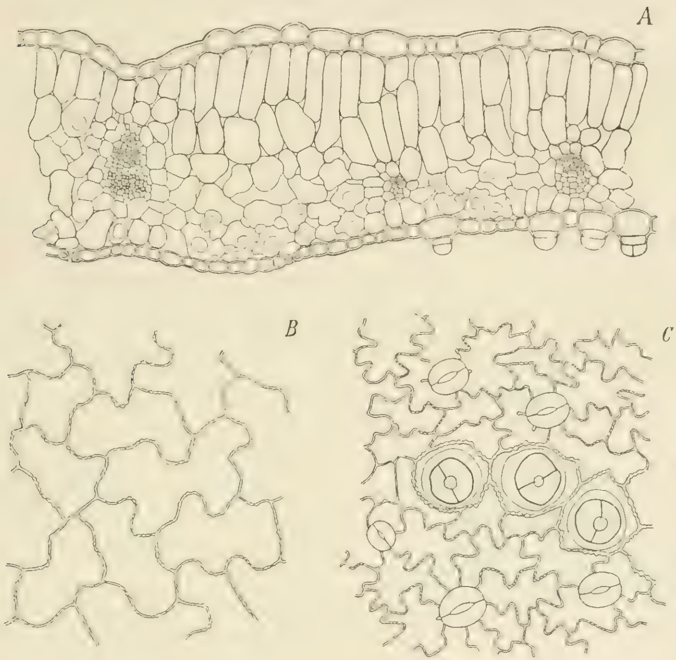


Fig. 24. *Pedicularis lapponica.*
A, Transverse section of the leaf. *B*, Epidermis of the upper, and *C* of the lower surface of the leaf. (Greenland.) (*A* about $^{110}/_1$; *B* and *C* about $^{220}/_1$.)

phyll in the cortical cells. In the cases in which the basal portions of the flowering-shoots persist and bear lateral shoots, a second growth-ring — often excentric — may be formed here.

The Leaf: As regards the anatomy, there appears to be very little difference between the rosette-leaves and the leaves of the floral shoots. The epidermis of the upper surface (Fig. 24, *B*) has straight to slightly undulating lateral

walls; those of the epidermis of the lower surface (Fig. 24, *C*) are more strongly undulating. The lateral walls of the epidermal cells of both the upper and lower surface, although thin, are yet very distinctly porose, those of the upper surface, more strongly so. Stomata occur only upon the lower surface, the guard-cells are surrounded by 4—6 cells. In transverse section (Fig. 24, *A*) 1—2 layers of palisade-cells are seen; the spongy parenchyma is composed of highly-branched cells (the small circles inside the cells of the spongy parenchyma indicate the branches which have been cut through on preparing the section); chlorophyll-grains are present abundantly in the whole of the mesophyll, also in the epidermis of the lower surface; the stomata occur on a level with, or are raised slightly above, the leaf-surface. The final branchings of the veins end in an epithema-like tissue of somewhat inflated, thin-walled tracheids.

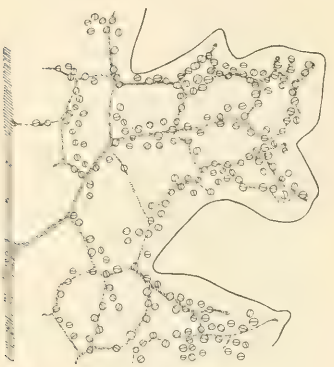


Fig. 25. *Pedicularis lapponica.* A portion of a leaf-section seen from the lower surface; the glandular hairs are seen to be crowded under the veins (about $^{35}/_{1}$).

Very characteristic of the leaves of the *Pedicularis* spp. are the numerous glandular hairs of the type shown in Fig. 24, *A* and *C*. Fig. 25 shows a portion of a leaf-section seen from the lower surface, — the glandular hairs are found here only —, the veins are drawn as if visible through the mesophyll, and the glandular hairs are seen to be crowded under the veins, the same feature is recorded by Hovelacque (l. c.) in the case of other species of *Pedicularis*. In Fig. 24, *C* three glandular hairs are seen from above; the epidermal

cells from which they have developed, have far thicker and more highly porose lateral walls than the surrounding cells; the finely-drawn circle which surrounds the thickly-drawn glandular-head, indicates the place of contact between the basal cell of the hair, and the outer wall of the epidermal cell; the smaller circle at the top of the head indicates that the cuticle at this place is lacking, thus forming a pore only spanned by the cellulose wall, as described by PERCY GROOM for *P. palustris.*

Pedicularis sudetica Willd.

Herbarium-material from the shore of Hudson Bay (Churchill), King Point, King William's Land, Southhampton Island, Port Clarence, Taimyr Peninsula, Chabarowa, Nova Zembla and Lapland.

Lit.: LANGE, 1880, p. 75; KJELLMAN, 1882 (I), p. 256; 1882 (II), p. 325; 1882 (III), pp. 361, 363 and 366; 1882 (IV), p. 509; KJELLMAN and LUNDSTRÖM, 1882, p. 303; HOLM, 1885, p. 43, tab. VI, fig. 10, tab. VII, figs. 1—7; WARMING, 1890, pp. 207 and 215; EKSTAM, 1897, pp. 118, 166, 168, 176 and 180; KNUTH, 1899, p. 191; SIMMONS, 1913, pp. 123 and 138.

Sympodial hemicryptophyte of semi or entirely rosette type, the above-ground part of the shoot bearing the inflorescence being either furnished with a few foliage-leaves, or being totally devoid of them.

The species may form tufts, (a specimen from Herschell Island belonging to forma *lanata* Walpers, had numerous rosettes of foliage-leaves, even seven flowering shoots and 10 withered peduncles from previous years) and in this case it has a short mesocorme ("rhizoma multiceps"), a fairly thick primary root, sometimes probably of long duration, adventitious roots being only few in number, but rather vigorous; more frequently it appears, however, that the basal portion of the main shoot dies away, perhaps even

after the first flowering period; the main root is then less vigorously developed, and slender adventitious roots, also from the rhizome-portions of the innovation shoots, are abundantly developed, a circumstance which permits those shoots to continue their existence as independent individuals, after isolation from the main shoot — consequently, the species can be propagated vegetatively (cf. Ekstam).

This difference in the growth is probably conditioned by the nature of the habitat; the tufted individuals must be assumed to have grown on drier soil, while the other form must have lived in damper localities; the fact of my having found *Sphagnum* in connection with the rhizomes of many specimens of the latter type, indicates moist moss-tufts as their habitats.

As regards the duration of the first vegetative stage, it is not possible for me to state anything with certainty, owing to want of material; in a comparatively weakly-developed individual, I estimated its extent as three years.

Fig. 26, *1* shows an individual produced from an isolated innovation shoot; (the figure has been drawn from soaked herbarium-material, and is somewhat diagrammatic). At the base of the relatively-main axis, we see the separation surface (scar) along which it has loosened itself from the parent-shoot; during its first year, the shoot has formed a few-leaved rosette of foliage-leaves, and completed the year's growth by the formation of scale-leaves, for the protection of the winter-bud; (at *I* some fragments of the first year's leaves are seen; the bud *A* is dead). Next year a piece of stem, about 1 cm long and only bearing 2 leaves, was first produced, next a rosette of foliage-leaves, followed in turn by scale-leaves, of which three still remain (two only can be seen). The process is repeated in the following (3rd) year, and simultaneously the buds *C* and *D* in the axils of the

scale-leaves of the 2nd year, expand and produce a few foliage-leaves, some of which still remain in a withered condition (c_1 and d_1 respectively). In the fourth year the individual at last flowered; *IV* indicates the lower portion of the peduncle. *C* and *D* which, like the terminal bud of the shoot,



Fig. 26. *Pedicularis sudetica.*
1, Basal portion of a plant, somewhat diagrammatic; as regards the explanation of letters and numbers cf. text on pp. 432—434. *2*, A flower seen in side view. *3*, The upper lip seen in side view; the reciprocal position of the anthers and pistil is indicated. *4*, Stigma, more highly magnified. (Nova Zembla.) (*1* about nat. size; *2* and *3* about $^3/_1$; *4* about $^{50}/_1$.)

have been protected during the winter-rest by scale-leaves, are forming their second leaf-rosette, the leaves of which are indicated by c_2 and d_2 respectively; and *B*, which rested during the previous summer, has now developed a foliage-leaf, b_2;

the now dead leaves x and y are from the leaf-rosette formed the year before the main shoot flowered; from the axil of one of the uppermost bud-scales, an innovation shoot E has also been developed, and is expanding its first two foliage-leaves.

Here, consequently, the vegetative-stage has lasted 3 years, and this appears to be the rule in individuals of this type; in the tuft-forming type in which, in dried material, this question is far more difficult to decide, it appears to me that the vegetative stage can be restricted to two years.

It still remains to be noted that, although the majority of the individuals which result from isolated innovation shoots, had elongated internodes inserted between the rosettes, yet only rarely were they as long as is shown in Fig. 26, *1*; the phenomenon is probably due to the endeavour of the plant to keep its terminal bud in a certain position relative to the surface of the substratum. In Fig. 26, *1* adventitious roots are developed only at the base of the shoot, but these may also be developed below the other rosettes, often in great numbers. They are 1—2 mm thick. I never found haustoria on such adventitious roots, but they occurred on the root-branches in the specimen from Herschell Island, mentioned above.

From Nova Zembla plants were to hand of which the peduncle was only 5 cm high during flowering; in specimens from Chabarowa it was 17 cm, and in one from Churchill, even 25 cm high; after flowering an elongation of the axis of the inflorescence takes place.

Fig. 26, *2* shows a flower seen from the side. The position of the stigma should be noted, and the two pointed lobes in which the front part of the helmet terminates, and the ridge, with the veins which proceed from it into the helmet, also the slightly warty revolute portion of the edge of the upper lip, and the two convexities on the lower lip;

as stated by E. WARMING, the latter is somewhat oblique. The calyx is drawn as densely hairy, this is the case in forma *lanata* Walpers. In Fig. 26, *3* the position of the stamens inside the helmet is shown. It must be borne in mind that the natural position of the flower is almost horizontal, whence it follows that self-pollination must be able to take place with comparative ease, for the pollen will be sprinkled out of the front opening of the helmet by accidental movements of the plant, caused for instance by the wind, and will fall upon the hinder side of the stigma, which, as shown in Fig. 26, *4* is almost globular.

EKSTAM has studied the species in Nova Zembla, and he writes concerning this: "Ziemlich häufig — häufig an besonders nassen Orten. Besitzt einen ziemlich starken jasminähnlichen Wohlgeruch und hell- bis dunkelrote Blüten. Schon in sehr jungen Knospen ragt die Narbe aus der Oberlippe hervor — in einer ganz aufgeblühten Blume etwa $2^1/_2$—3 mm — und wird bald papillös, gewöhnlich bevor die Blume ganz aufgeblüht ist, und die Antheren sich geöffnet haben. Selbstbestäubung dürfte dadurch ermöglicht werden, dass die kugeliche Narbe rund umher papillös ist, und in der Falllinie der Pollenkörner gelegen ist. Nachdem die Antheren sich entstaubt haben, bleibt die Narbe noch eine Zeit lang glänzend, papillös. Blüth im Hochsommer. Mit reifen Früchten beobachtet. Anemophile Samenverbreitung. . . . . Wurde am $^{31}/_7$ von einer kleinen Fliege, am $^6/_8$ von einem grossen Bombus hyperboreus Schönh., am $^{18}/_8$ ebenfalls von einem grossen Bombus hyperboreus Schönh. besucht. Im Sommer 1891 trotz fleissiger Beobachtung kein einziger Insektenbesuch bemerkt."

In somewhat vigorous specimens, the exceedingly dense inflorescence, with the deep-red corollas, cannot fail to be very conspicuous.

The Geographical Distribution, according to Simmons and Lange: Western Arctic and Subarctic North America, (both the continent and the archipelago), Arctic Siberia, Nova Zembla, Arctic Russia and besides on mountains

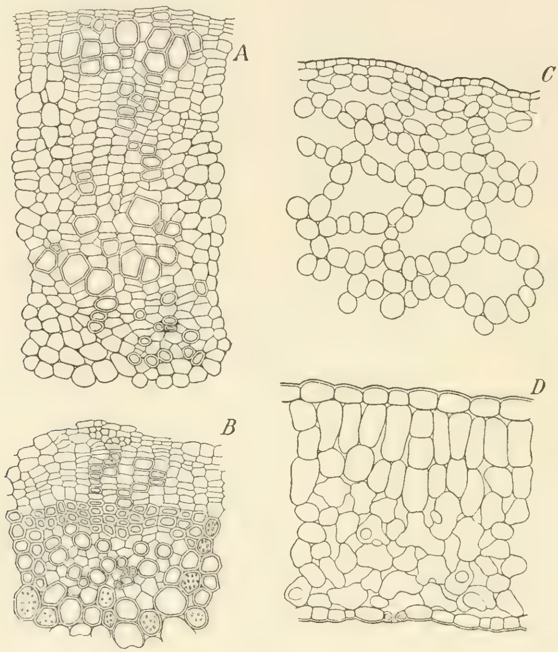


Fig. 27. *Pedicularis sudetica.*
A and *B*, Portions of transverse sections of the rhizome of the individual illustrated in fig 26, *1* (cf. text). *C*, Epidermis and the outer layers of the cortex of the same rhizome. *D*, Transverse section of the leaf. (Nova Zembla.) *A* and *B* about $^{140}/_{3}$; *C* about $^{70}/_{1}$; *D* about $^{110}/_{1}$.)

(Sudeten and Riesengebirge) of Central Europe. Does not occur in Greenland.

According to Kjellman (1882 (III)) the flowering year's-shoots of *P. sudetica* in a pressed and fermented condition, and the roots, rhizomes and buds in fresh condition, are used as food by the Chuckes in Eastern Arctic Siberia.

Anatomy. An adventitious root about 2 mm thick

showed the following structure: Of the exceedingly thin-walled epidermis only scattered fragments were left, the cells were dead and had collapsed. The outermost layer of the cortex had cuticularised outer and lateral walls (it must certainly be this layer which TH. HOLM in his Fig. 7, Tab. III, designates epidermis); the layer just within the outermost layer adjoins the latter without or with small intercellular spaces between them; the endodermis has distinct Casparian dots. The intervening part of the cortex consists of a very lacunose tissue, which corresponds exactly with that in the rhizome (shown in Fig. 27, *C*). Such slender adventitious roots complete their development during one season of growth; their structure is 2-rayed, and by the secondary growth there is formed a bundle of xylem-tissue, about 0.5 mm thick consisting of vessels with intervening non-lignified tissue.

Of the individual figured in Fig. 26, *1* a transverse section of the axis was taken from the part between *I* and *II*, and also one between *II* and *III*; the former part must be assumed to be 3 years old, and the latter 2 years. In the part between *I* and *II*, there was found in the stele a circle of vascular bundles, separated by broad, non-lignified, parenchyma-rays (cf. Fig. 27, *A*, which shows the xylem part of a vascular bundle). In the second year of growth an increase of the vascular elements has evidently taken place, the lowermost (i. e. in the stem innermost) group of wide vessels probably indicates the limit of the first year's growth; what is found outside that belongs then to a later (probably the second) year. Wood-fibres are quite absent: [illegible]e the pith does not die away. Fig. 27, *B* is drawn from a [illegible]on taken from the part between *II* and *III*, at about the middle of it. Here the axis is hollow, because the central part of the pith, as in the peduncle, has died away; the walls of the outermost layers of the pith have

become thickened, lignified and porose, the same is seen to be the case as regards the inner part of the parenchyma-rays, which separate the vascular bundles. Around the vessels non-lignified elements occur, but the limit of the first-year's growth is shown in the vascular bundles by a layer of wood-fibres, 2—3 cells thick, which adjoins the lignified parenchyma rays, so that a continuous stereom results. The few scattered vessels outside this I regard as the growth of the second year; such small groups of vessels may also occur in the space between any two of the original vascular bundles. A second individual exhibited a similar structure, but in a third I found no trace of a second-year's growth; unfortunately the scantiness of the material prevented my studying this point more thoroughly. A portion of the cortex is shown in Fig. 27, *C*; with the exception of the two outermost layers it is very lacunose in structure. The epidermis is small-celled, and furnished with a rather thick cuticle.

The Leaf. The epidermis is of the usual *Pedicularis*-type, the lateral walls of the cells are thin and only slightly porose, very similar to those in *P. hirsuta* and *lanata*. Stomata occur only on the lower surface of the leaf; the guard-cells are on a level with the other epidermal cells. A transverse section is shown in Fig. 27, *D*; the part which has been illustrated is typical and also agrees well with Th. Holm's Fig. 4, Tab. VII. The upper half of the mesophyll consists of 2—3 layers of short, thick palisade-cells, and the lower half of spongy parenchyma composed of rather decidedly branched cells. Chlorophyll occurs abundantly in the whole of the mesophyll. Glandular hairs of the same form and size as in the other species of *Pedicularis*, occur also in *P. sudetica* on the lower surface of the leaf — not as Th. Holm (l. c. p. 44) writes "here and there," but in abundance below the branches of the veins of tertiary and higher

order. On the lower surface of the leaf, and especially in the middle of the sections, thin-walled 1- to 3-celled non-glandular hairs occur.

Pedicularis euphrasioides Steph.

Alcohol-material from Greenland (Itivnek near Holsteinsborg, leg. Eug. Warming, 13. 7. 1884).

Herbarium-material from Greenland, the shore of Hudson Bay (Churchill), Port Clarence near Behrings Strait, and Siberia (by the Boganida River).

Lit.: Lange, 1871, pp. 254 et seq, 264, tab. II, fig. 10 (the seed); 1880, p. 74; 1887, p. 262; Warming, 1886, pp. 19, 44 and 58; 1890, pp. 206, 210, 211 and 218; Rosenvinge, 1892, p. 686; 1896 (I), p. 68; 1896 (II), p. 78; Hartz, 1894, p. 39; Knuth, 1899, p. 190; Porsild, 1920 p. 142.

Spot-bound hemicryptophyte of the semi-rosette type, biennial to pluriennial hapaxanth, or — what is certainly the most common — a pollacanth, with scantily-branched main root, the longevity of which corresponds with that of the individual. Should the species appear as a pollacanth, innovation shoots are developed at the base of the flowering shoot.

The length of the first vegetative-stage varies from one to (probably at most) two years. During the vegetative stage a leaf-rosette is developed every summer and — towards the end of the growth-period — bud-scales for the protection of the young organs during the winter-rest; in the summer in which the plant flowers, the shoot forms no rosette of foliage-leaves. The shorter vegetative-stage (of one-year's duration) appears especially to result in weaker individuals, which probably often end their lives by fruit-setting in the second year.

This species differs very much in habit from the other species described here, owing to the formation of numerous

branches which, during the flowering year, arise in the axils of the foliage-leaves on that part of the stem which has elongated internodes. These lateral shoots increase in length downwards to some way below the middle of the parent-shoot, and then again become shorter towards its base; here they are often purely vegetative, while the upper ones bear, in addition to 2—3 decussated pairs of foliage-leaves, a small inflorescence corresponding with that of the parent-shoot.

In the pollacanthous individuals the innovation shoots are produced in the axils of the uppermost bud-scales; they usually develop only a few pairs of opposite foliage-leaves, then bud-scales, and then the following year, they most often terminate their growth by the formation of an inflorescence. I cannot deny that there is a possibility of the innovation shoots also flowering without any preceding rosette-formation, and therefore, in their first year, developing only bud-scales; in this case the species would be a transitional form between the semi-rosette type and the protohemicryptophyte-type.

In individuals in which a "rhizoma multiceps" is developed, the uppermost part of the main root may become as much as 2 cm thick.

The flower-bearing stem may become as much as 25 cm high; after flowering, the axis of the inflorescence is somewhat elongated.

On the basis of material from Greenland (about 67° N. lat.) E. WARMING gives the following description of the structure of the flower (cf. Fig. 28): "This species, which is in no wise common in Greenland, is very conspicuous owing to its numerous inflorescences with yellow, fragant flowers; the tip and the helmet of the yellow corolla is slightly brownish. The flowers are very oblique, the lower lip being highly oblique (Fig. 28, *A*, *B*, *D* and *H*); but the upper lip also is

twisted in such a manner that its two-toothed tip turns somewhat to the right (*E*). The ridge reaches the edge slightly above the beginning of its revolute portion (*A* and *G*). The slit between the two edges of the upper lip is usually rather narrow. The front filaments are sparingly hairy. The stigma protrudes more or less above the two teeth (*B*, *D*, *E* and *H*).

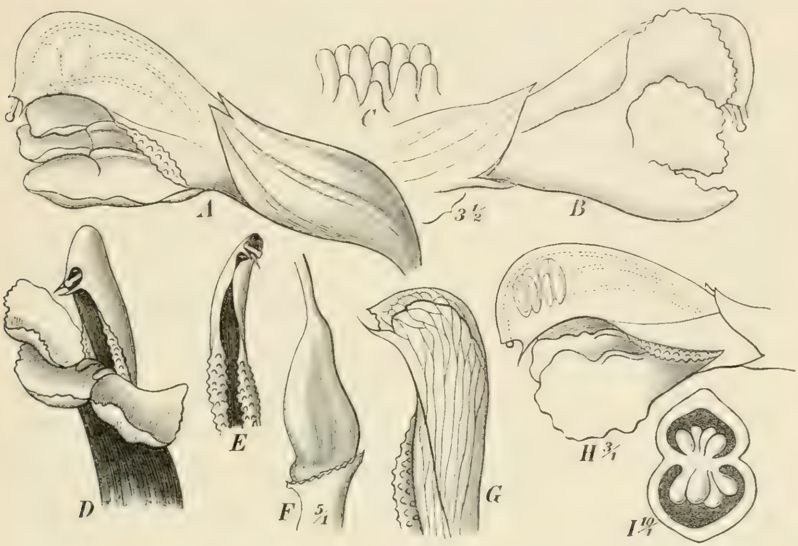


Fig. 28. *Pedicularis euphrasioides.*
(From Greenland; about 67° N. lat.)
A, *B*, A flower seen from the left and the right side; in *A* the position of the style and the stamen is indicated. *C*, Stigmatic papillæ. *D*, A flower in front view. *E*, The upper lip seen in front view. *F*, The ovary. *G*, The upper lip seen in side view; the venation is indicated. *H* shows the same as *A*. *I*, Transverse section of ovary. (Drawn by E. WARMING, 1890.)

Judging from the structure of this almost horizontally-placed flower (*A* and *B*), I must assume that it is only with difficulty that it pollinates itself. It produces ripe fruit in Greenland at 67° N. lat."

Geographical Distribution. West Greenland between 62° (but only in a few localities south of 64° N. lat.)

and 69°30′ N. lat. (Rosenvinge, 1892), on the whole rather rare there; Labrador, the Rocky Mountains, the continent of Arctic America, (but not mentioned by Simmons from the Archipelago), Siberia and Dahuria.

In Greenland it grows on luxuriant, damp heaths; the species requires a snow-covering during its winter-rest (M. Porsild, 1920).

Anatomy. The root is of the type described later on in *P. hirsuta* and *lanata* and, as in these, the secondary cortex is traversed by numerous radial clefts. There is, however, a difference between *P. euphrasioides* and the two species in question as regards the nature of the xylem-part, because, in the two former it is composed of a large quantity of non-lignified tissue and of relatively few vessels only, whilst in *P. euphrasioides* one always finds in the root several concentric rings, each consisting of numerous vessels with intervening lignified stereom (thin-walled wood-fibres). These continuous rings of lignified elements, the outlines of which are however somewhat undulating, are separated by portions in which the vessels are not so wide or numerous, and are surrounded by non-lignified tissue; here clefts occur between the radiating lines of vessels.

That these rings of vessels and wood-fibres really indicate zones of annual growths, is evident from the investigation of some specimens chosen from among the individuals in my material, which had flowered for the first time: such as — judging from the leaf-scars — had had only a vegetative-stage of one-year's duration (that is to say, flowered in the second year) showed two rings; others which, as far as I could see, had had a vegetative-stage of two-year's duration, showed three rings. The greatest number I succeeded in demonstrating amounted to three.

The cavity of the stem is comparatively large. The

cortex is thin; in the xylem-ring the wood-fibres dominate in the 3—4 outermost layers; the cell-layers in the periphery of the pith are lignified, thickened and porose. On the epidermis there are found non-glandular hairs of the same type as on the leaves.

The Leaf. A transverse section of one of the leaves

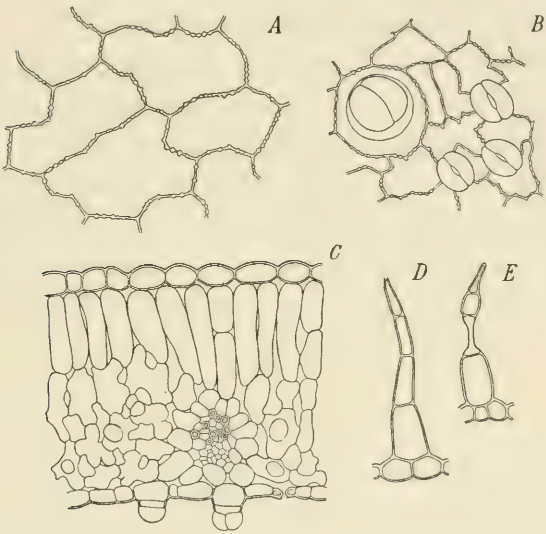


Fig. 29. *Pedicularis euphrasioides.*
A, Epidermis of the upper, and *B* of the lower surface of the leaf. *C*, Transverse section of the leaf. *D* and *E*, Non-glandular hairs from the surface of the leaf. (Greenland.) (*A* and *B* about $^{220}/_{1}$; *C* about $^{110}/_{1}$; *D* and *E* about $^{140}/_{1}$.)

from the middle of the stem, is shown in Fig. 29, *C*. There is generally found only one layer of rather elongated palisade-cells, below these there is usually a layer of cells which, although elongated, are nevertheless branched (this is distinctly seen to the left in Fig. 29, *C*), and which must therefore most naturally be included in the spongy parenchyma; the lower layers of the latter consists of richly-branched cells.

The epidermal cells of the upper surface has thin, slightly

undulating lateral walls, those of the lower surface are still more thinwalled, their lateral walls more highly undulating and, as in the epidermis of the upper surface, furnished with flange-like thickenings, which I found to be particularly well-developed in the bracts of the flowers, and, on the whole, in the upper leaves on the axis. Stomata occur only on the lower surface; the guard-cells are on a level with the other cells of the epidermis; they are surrounded by 3—6 cells. Chlorophyll is abundantly present in the whole of the mesophyll and is also found in the epidermis of the lower surface. On the lower surface there are glandular hairs of the usual kind, and with the typical distribution; and besides there are non-glandular hairs both on the upper and the lower surface (Fig. 29, *D* and *E*); they are multicellular and thick-walled, often however with one or two cells unthickened and therefore collapsed.

Pedicularis Sceptrum carolinum L.

Alcohol material from Aursundsöen, Norway (leg. Th. Resvoll, 11. 8. 1918). — Herbarium material from the district near the river Boganida, Alten, Mortensnæs in East Finmark, and the Murman Coast.

Lit.: Lange, 1871, pp. 254 et seq., 267, tab. III, fig. 25 (the seed); Warming, 1890, p. 215; Norman, 1895, p. 456; Kerner, 1898, Bd. II, p. 655; Knuth, 1899, p. 191; Silén, 1905, p. 92.

A sympodial hemicryptophyte of rosette- or semi-rosette type, with vertical or obliquely-ascending mesocorme, which dies away behind, and from which adventitious roots, 1—2 mm thick, are abundantly developed.

2-year-old specimens, from Aursundsöen, showed that the plant in its first year forms a few-leaved rosette; the winter-bud is protected by scale-leaves, and the following year the growth is continued by the formation of a more

luxuriant rosette. I can state nothing as regards the duration of the first vegetative-stage, the 2-year-old plants in question were still rather frail. The hypocotyl was somewhat elongated, the adventitious roots had already begun to develop, and in one of the individuals, a lateral shoot had been produced in the axil of a rosette-leaf of the first year.

On the rhizomes, innovation-shoots, from 1 to 3 in number, occur; their vegetative stage, judging from the material at my disposal, which is however but scanty, extends over 2 years: During the first year 2—4 foliage-leaves are developed, and then scale-leaves, which serve as bud-scales for the winter-bud; during the next year a somewhat more dense rosette is developed, again succeeded by scale-leaves; and finally the shoot, during the 3rd year, after having formed a luxuriant rosette, terminates in an aerial, flower-bearing portion, which is often quite destitute of foliage-leaves, and may attain a height of even 60 cm.

The fact that the rhizome dies away behind, in conjunction with the abundant development of adventitious roots, must allow of vegetative propagation, since the lateral shoots gradually become free and independent by the dying away of the parent rhizome.

E. Warming (l. c. p. 215 et seq, figs. 30 and 31) gives the following description of the structure and biology of the flower, on the basis of material from Kola, and from Østerdalen in Norway; his two groups of figures are reproduced here as Fig. 30 and Fig. 31.

"The flowers are . . . . as much as 32 mm long; they stand erect, the subtending bracts are closely adpressed, and in addition each flower appears to be completely closed. The lower lip (Fig. *E*) is erect, 14—15 mm long, pressed closely to the upper lip, which is a little longer (16 mm), and closes the throat completely, but is easily pressed down. The visit-

ing insects must evidently be large and vigorous, such as humble bees and moths, and they must, in a way similar to that in *Antirrhinum* and *Linaria*, press their body or head down between the two lips, by which means they primarily come into contact with the stigma; Fig. 30, *B* shows (the lower lip having been removed) that the stigma can be so protruding that contact with it must be regarded as inevit-

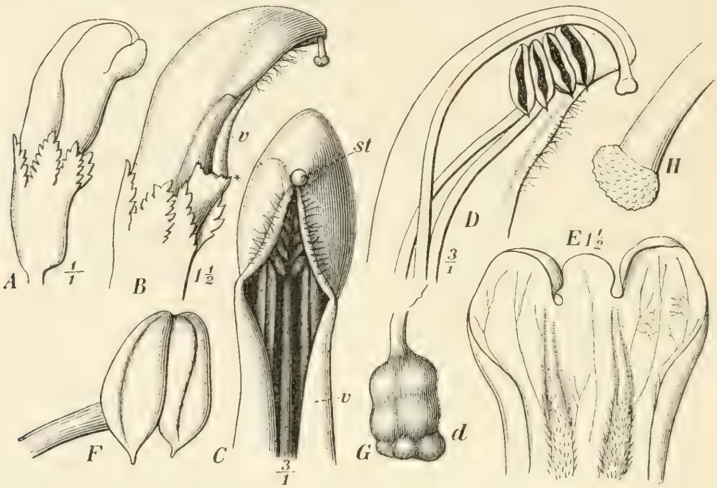


Fig. 30. *Pedicularis Sceptrum carolinum.*
From Kola near the White Sea (collected by Dr. Brotherus).
A, Flower, natural size and position. *B*, The same after the lower lip has been removed (*D* belongs to this). *C*, Part of a 25 mm long flower, seen in front view; the stigma protrudes less than it does for instance in *B*; the anthers have not yet opened (see *F*); to this belongs the tip of the style shown in *H*. *E*, The lower lip of *B*. *G*, Ovary. *v* indicates the revolute portion of the edge of the upper lip. (E. Warming, 1890.)

able; that cross-pollination must take place by the agency of large insects, is also evident from the fact that the distance from the stigma to the nectary may be as much as 2.5 cm. I have also several times seen the stamens torn off the upper lip, evidently by the violence of a large insect. In one of the flowers (*C*) which has been illustrated, the anthers had

not yet opened (*F*), and as the stigma appears to be ripe (*H*), protogyny must consequently prevail. When the anthers have afterwards opened (*D*) it must evidently be the insect knocking against the filaments, which shakes the pollen down over it; strange to say, both the filaments, anthers, style as well as the revolute portions of the edge of the upper lip, are quite glabrous (see *B*, *C* and *D*) so that there is no special contrivance which by its resistance increases the shock. On the other hand, hairs occur — which are probably of importance in preventing the pollen-grains from falling out at the sides — viz., along the edges of the upper part of the upper lip (*B*, *C*, *D*), consequently, in the same place as ordinarily, but on another organ.

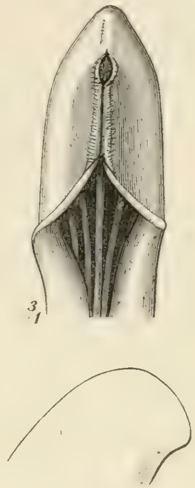


Fig. 31. *Pedicularis Sceptrum carolinum.* From Kola. The upper lip in front and side view. The anthers are open. In the front there is a flat or incurved part, and the slit is tightly closed above. In this case the stigma does not protrude, but stands just within the uppermost end of the slit. (E. Warming, 1890.)

For the rest, the width of the slit of the upper lip, and the degree to which the stigma protrudes, differ also. While the stigma protrudes far out in the quite young flower *B*, it does not protrude so far in the young *C*, and still less in Fig. 31 (also in this paper Fig. 31) of which the anthers are already open . . . . Self-pollination appears to be able to take place only with difficulty. As the species sets fruit abundantly in so northerly a region as near Alten (about 70° N. lat.) it must undoubtedly be humble-bees that effect pollination."

Conditions pertaining to the pollination of the flower

have afterwards been studied by Silén, who writes: "Were much-visited by humble-bees, which forced themselves into the closed flowers, which were thereby torn open on the one side, seen from the front, the right side, whereby the lobes of the lower lip are bent outwards. After the visit of a humble-bee, the flower cannot close again. The smaller humble-bees penetrate entirely into the flowers, whilst the stomach of the larger ones remains visible outside the flower."

In flowers from Aursundsöen I found the lower lip to be relatively somewhat longer than is figured by Warming; the length of the style was, on the whole, the same as that shown in Fig. 30, *B*. Many of the older flowers in the inflorescences had been opened by the visits of insects.

Geographical Distribution: Fennoscandia, Lapland, Western and Northern Russia, Siberia as far eastward as to the river Kolyma, Mantchooria and Japan. Besides this, the species has an area of distribution in Central Europe (Germany, with a southern limit in the Bavarian Alps); here it is possibly a glacial relict (Kerner).

According to Norman, in Northern Norway the species grows in bogs, on boggy plains, on the coast and in willow copses.

Anatomy. The Root. The epidermis remains long intact. The cells in the outermost layer of the cortex are provided with a cuticularised lamella along the whole of their circumference; between this exodermis and epidermis there are no intercellular spaces, and such are wanting also between the exodermis and the outermost layer but one of the cortex; further inwards, the cortex becomes rather lacunose. Starch occurs in the cortical cells. The endodermis is a typical Casparian sheath. When the secondary growth in the stele is completed, a small central group of vessels, circular in outline, is found to be developed.

The Peduncle. A portion of a transverse section is shown in Fig. 32, *A*. The layer of complete cells seen uppermost in the figure, is the endodermis. The pericycle is several-ayered; sieve-tissue occurs rather sparsely. The vigorous development of the stereom of the peduncle, is characteristic

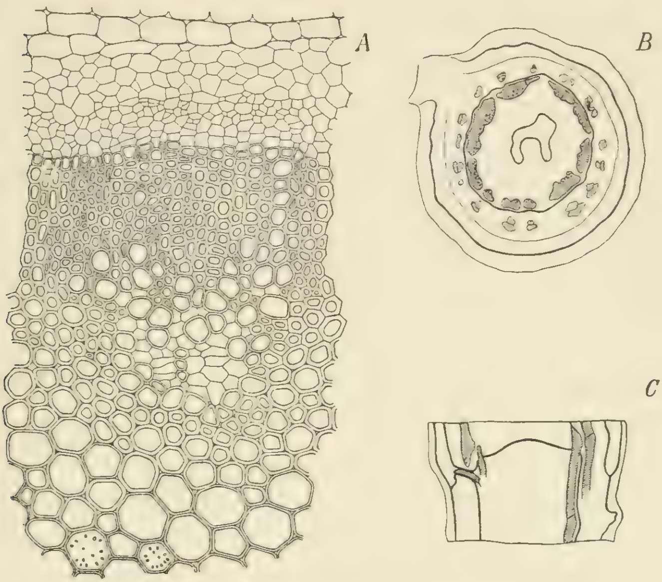


Fig. 32. *Pedicularis Sceptrum carolinum.*
A, Portion of a transverse section of peduncle. *B*, Transverse section, and *C* longitudinal section of the upper part of a rhizome; *B* and *C* diagrammatic, cf. text. (Aursundsöen, Norway.) (*A* about $^{220}/_{1}$; *B* and *C* about $^{6}/_{1}$.)

of the species. In the mass of wood-fibres only here and there a radial row of vessels is inserted — in the figure the 4th row from the right hand is such a radial row. In between the groups of the primarily formed vessels, of which one is seen in the middle of the figure, the wood-fibres internally adjoins the peripheral portion of the pith, which also consists of strongly thickened, lignified and porose cells, so that in the fully developed stem the original groups of vessels are

found completely surrounded by a compact mass of stereom; only the tissue immediately surrounding the protohadrome remains unthickened and unlignified.

The anatomical structure in that portion of the stem which bears the rosette-leaves deserves a more special description.

A transverse section of an axis of an innovation-shoot in its first growth-period, about 3 mm thick, exhibited a distinct Casparian sheath, and in the stele a circle of small vascular bundles, separated by comparatively broad rays of intervening parenchyma; at a depth of about 3—5 layers of cells within the cortex there had been formed, even at that point of time, a cork-cambium which had produced a 3—6 layered cork (Sudan III).

The transverse section of a 2-year-old rhizome, with its richer 2nd year's leaf-rosette developed, exhibited in its uppermost part a structure similar to that described in the case of the one-year-old shoot, only, the diameter of the organ was larger (about 5 mm), the vascular bundles were more numerous and also individually broader, and they had on the outer side of the xylem-portions a thick cap of wood-fibres. In the basal portion of this shoot, which had been developed the year before, and which was consequently 2 years old, there occurred, however, a distinct growth-zone in the vascular bundles, since, either as a direct continuation of the xylem-portion developed during the first year of growth, and furnished on the outer side with a cap of wood-fibres, or else separated from that xylem-portion by 1—3 layers of thin, unlignified elements, one more xylem-portion was found, which also had a cap of wood-fibres along its peripheral portion, and evidently represented the growth of the 2nd year. Frequently, such xylem-groups of the 2nd year are also developed without being in connection with the

xylem-groups of the 1st year, viz., opposite the parenchyma-rays which separate the original vascular bundles. The cork in the primary cortex is constantly few-layered only.

Lastly, a portion of a rhizome of a 3-year-old shoot with a terminal peduncle, was investigated. The basal portion was found to be unaltered, as described above in the case of the 2-year-old shoot; in the part developed during the 2nd year of growth (illustrated diagrammatically in Fig. 32, *B*), fundamentally, the same development has taken place as that which, in the second year, took place in the basal portion, the only differences being that here the vascular groups are larger and more numerous, and the stereom-caps much thicker, and also that the two zones of growth are separated by a ring of non-lignified tissue (parenchyma) as much as 15 cell-layers thick, in which a layer of cork, consisting of 3—5 layers of cells, is developed; this layer of cork surrounds, in a tube-like manner, the xylem developed during the first year of growth. In the figure the cambium is consequently situated immediately outside the outermost circle of xylem-groups; the endodermis is in part distinct, and in the figure, is indicated by a fine line; the two thickly-drawn circles indicate the outer and inner cork-layer; within the pith there is another one like it, also indicated by a thickly-drawn line; in the outer circle of xylem-groups, the inner, dotted part indicates that this part consists especially of vessels, the outer radiately-shaded part, that there wood-fibres predominate, in the inner circle where the situation of the vascular- and stereom-elements is less sharply distinguishable, the whole of the xylem is shaded.

Where the rhizome bears the rosette of the 3rd year, it shows a transition to the structure of the peduncle, and gradually merges evenly into the latter — the wood-fibres form an almost continuous ring, and cork-development ceases.

Fig. 32, *C* shows a diagrammatic, longitudinal section of that portion of the 3-year-old rhizome described above, in which the boundary line between 2nd and 3rd year's growth occurs — here, also, the thickly-drawn lines indicate the cork-layers, and the xylem is shaded. As is evident from

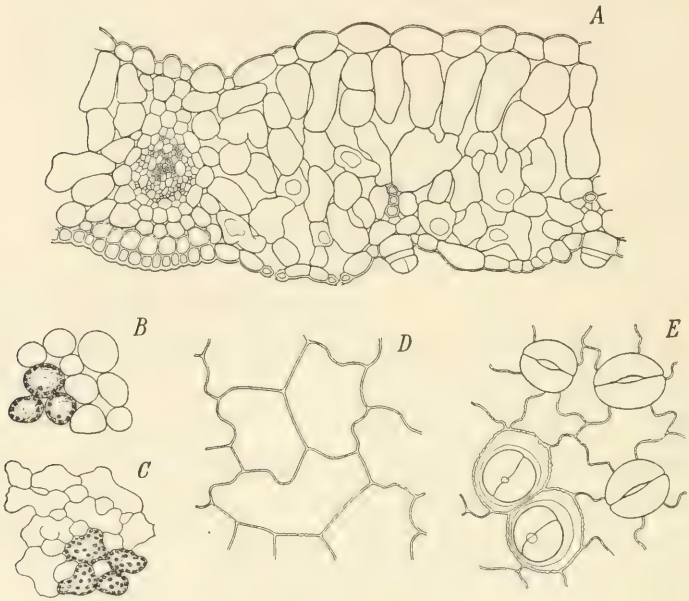


Fig. 33. *Pedicularis Sceptrum carolinum.*
A, Transverse section of leaf. *B*, Palisade cells, and *C*, spongy parenchyma in surface view. *D*, Epidermal cells from the upper, and *E* from the lower surface of the leaf. (*A*, *B* and *C* about $^{110}/_{1}$; *D* and *E* about $^{220}/_{1}$.) (Aursundsöen, Norway.)

the figure the inner layer of cork is continued horizontally in an inward direction, and forms a plate right across the pith; the outer layer of cork shows various irregularities.

A closer investigation of the process of development was not possible, owing to the very scanty material; as regards the development of a continuous layer of cork between the growth-zones of the xylem, it must be noted, that a similar

structure, according to the investigations of L. Koch[1] and E. Strasburger, is found in the aereal stems of *Sedum populifolium* L.

The Leaf. The epidermis of the upper surface has lateral walls, varying from straight to slightly undulating; only along the edges of the sections are the undulations more marked, very much as on the lower surface (Fig. 33, *D* and *E*). The lateral walls are thin, and faintly and distantly porose; only those cells on the lower surface which bear glandular hairs, have, as is also the case in the other species, thicker and more highly porose walls. The transverse section shown in Fig. 33, *A*, exhibits the lacunose structure of the mesophyll: the 1—2 layers of short palisade-cells, which tend to be almost isodiametric, and the usually abundantly-branched cells of the spongy parenchyma; a surface-view of the latter cells is shown in Fig. 33, *C*. Stomata occur only on the lower surface; the guard-cells are on a level with, or project only slightly above, the epidermal cells, which surround them to the number of 4—6. Chlorophyll occurs abundantly in the whole of the mesophyll, and also in the epidermis of the lower surface. Non-glandular hairs are totally absent; glandular hairs of the usual type occur in great numbers under the secondary veins, and the veins of higher order of the leaf-sections.

Pedicularis capitata Adams.

Herbarium-material from St. Lawrence Bay, King William's Land (Gjöa Harbour), Ellesmere Land, Kotzebue Bay, Island of Iglorlik and from near the Taimyr River.

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[1] L. Koch: Untersuchungen über die Entwicklung der Crassulaceen. Heidelberg, 1879, and E. Strasburger: Ueber den Bau und die Verrichtungen der Leitungsbanen in den Pflanzen. Jena, 1891. pp. 324—326.

Lit.: Lange, 1880, p. 78; 1887, 262; Kjellman, 1882 (I), p. 257; 1882 (IV), p. 511; Rosenvinge, 1892, p. 687; Eastwood, 1902, p. 288; Simmons, 1906, p. 26; 1913, pp. 125 and 139.

A sympodial hemicryptophyte of the rosette-type, which spreads by means of slender runners. The runners bear small scale-leaves and, rather scantily, adventitious roots, which are given off at the nodes; on some of the roots haustoria were found.

The length of the vegetative period of the innovation-shoot varies from 1 to 4 years; during the first year of growth it develops at its apex either a winter-bud only, or it first forms a small rosette of 2—4 leaves. In one single case I found the shoot already flowering in the following year, but as a rule a rosette of foliage-leaves is formed in one, two, (which appears to be the most common), or three more years. The flower-bearing axis is terminal, as much as 9 cm high, most frequently quite leafless, rarely with 1—2 foliage-leaves; at its apex it bears 2—6 flowers in a capitate raceme; some fresh leaves are always found at its base, since the shoot, also in the year in which it flowers, begins the year's growth by the development of a small rosette of foliage-leaves. The winter-buds are protected by scale-leaves.

In that part of the shoots where the leaf-rosettes are developed, branching seldom takes place; the new shoots arise most frequently from the portion of the runner immediately below the rosettes, or from the part of it, where it turns upwards. The runners are as much as 2 mm thick; how long they may become, I am not prepared to state, owing to the scantiness of the material, which would illustrate this point; several runners measured 3—4 cm. Sometimes they may be quite short, or a runner-like portion is entirely lacking at the base of the innovation-shoot, so that several flowering shoots may occur close together.

The structure of the flower is shown in Fig. 34, *A*—*D*; as I had only dried plants at my disposal, these drawings are somewhat diagrammatic.

As in *P. Sceptrum carolinum* the lower lip is directed upwards, on its inner side (morphological upper side) are two convexities. The maximum distance from the base of the corolla-tube to the tip of the helmet, was 3 cm; the

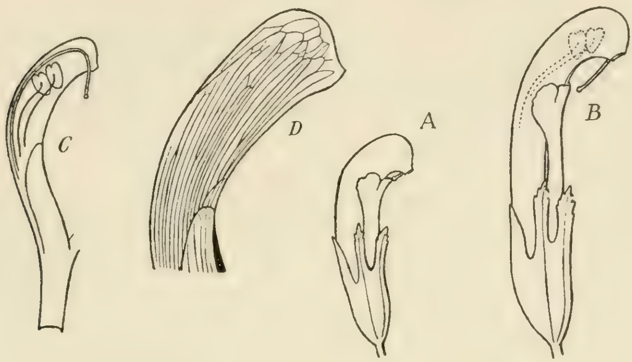


Fig. 34. *Pedicularis capitata.*
A, A bud and *B* a fully expanded flower; in *B* the position of the anthers is indicated. *C*, Corolla-tube and upper lip cut through the median plane of the flower, the lower lip has been removed. *D*, Uppermost half of the upper lip, more highly magnified in order to show the venation of the helmet; lowermost in this figure one sees the uppermost parts of the ridge and of the revolute portion of the edge of the upper lip respectively. (Ellesmere Land.) (*A*, *B* and *C* about $^3/_2$; *D* about $^3/_1$.)

colour of the corolla is yellow. The position of the ridge is shown in Fig. 34, *C*, and the venation of the helmet in Fig. 34, *D*; in the latter figure the uppermost part of the ridge is seen, and a little of the narrow revolute portion of the edge of the upper lip (entirely black in the figure). The revolute portion appears as if it were smooth, but, under the microscope, some of its epidermal cells are seen to be furnished with quite small, warty protuberances with cuticular striations; such protuberances are also found along the

edges of the helmet, above the revolute portion. The corolla-tube is somewhat hairy within, in its lower part.

The length of the style and the position of the stigma varied greatly, even in flowers from the same plant. The relatively longest-styled flower in my material was the one shown in Fig. 34, *B*; the plant to which it belonged came from Ellesmere Land; Fig. 34, *A* shows a not yet open flower from the same plant. From Ellesmere Land I have, however, also had flowers in which the style was so short that it hardly reached outside the tip of the helmet, whilst in others it protruded 1—2 mm outside, but was bent more or less decidedly upwards.

In several specimens from King Point there were flowers in which the end of the style was bent so strongly inwards, that it came to lie within the edges of the helmet, close up to the anthers. Some flowers from the Island of Iglorlik showed that, in the older ones, the point of the style may be bent more inwards than in the younger ones of the inflorescence; anything corresponding to this I have, however, not succeeded in confirming in flowers from the other localities. With the exception of the cases in which the stigma protrudes slightly, self-pollination by falling pollen must easily be able to take place, naturally, more especially where the stigma, is bent close under the anthers.

According to Simmons *P. capitata* flowers on Ellesmere Land at the beginning of July, and in most years does not, in all probability, succeed in setting fruit there, for which reason it will often be under the necessity of reproducing itself vegetatively by means of its runners.

As regards its habitat, Simmons remarks, that the species grows chiefly in marshy soil, but may also be found in drier localities where, however, the inflorescence becomes poorer (1—2 flowered).

According to the same author, the Geographical Distribution of *P. capitata* is as follows: North-western Greenland, Arctic American Archipelago, Arctic America, Unalaschka, East-Arctic Siberia to Taimyr Peninsula, and Kamschatka.

Anatomy. The Root: The structure of evidently full-

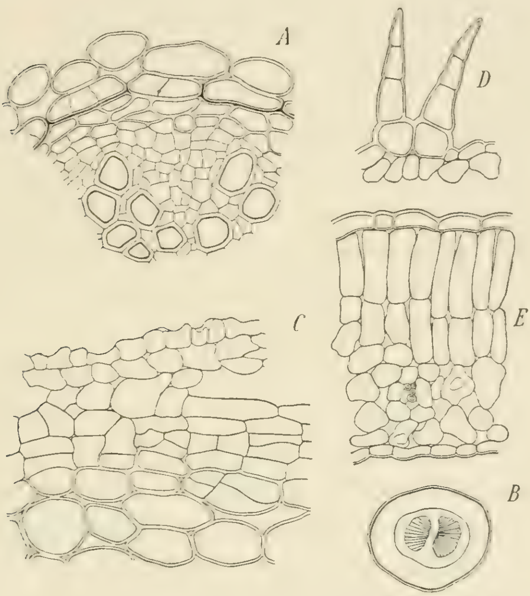


Fig. 35. *Pedicularis capitata.*
A, Portion of a transverse section of root. *B*, Transverse section of a runner, diagrammatic, cf. text. *C*, The peripheral layers of a runner in transverse section, showing the cork-formation. *D*, Two non-glandular hairs from the lower surface of the leaf. *E*, Transverse section of leaf. (*A* and *C* about $^{220}/_1$; *B* about $^{16}/_1$; *D* about $^{140}/_1$; *E* about $^{110}/_1$.)

grown adventitious roots, about 0.5 mm thick, was as follows: The epidermis appears to die away rather quickly; the cells in the outermost layer of the cortex have cuticularised outer and lateral walls; the cells under the exodermis were frequently divided by a thin tangential wall. The

cortex is few-layered (5—7 layers), the cells in the 3 outermost layers unite closely without any intercellular spaces; starch is found in the cortical cells.

During the secondary growth of the root, the endodermal cells are elongated tangentially, as are the other elements of the cortex and, are divided as the exodermal cells, by thin radial walls, into 2—4 cells; moreover, in the inner walls, and in the primary radial walls, there is formed a cuticularised lamella (the thickly drawn line in Fig. 35, *A*), so that the stele becomes, so to speak, surrounded by a tube of cuticularised material, only interrupted by non-cuticularised passage-cells opposite to the protohadrome-rays; (the roots investigated were 2—3 rayed). The secondary growth of the root stops when a thin bundle of xylem-tissue, circular in outline, and surrounded by a narrow zone of sieve-elements, is developed in the stele.

The Peduncle presents nothing particular in its anatomy. Chlorophyll-grains are found in the cortical cells, the cells of the outer layer of the cortex have somewhat thickened outer and inner walls; the endodermis has recognizable Casparian dots. In the periphery of the xylem-ring the wood-fibres dominate; the outer layer of the pith has thickened, woody, porose cell-walls; the central cells of the pith are thin-walled and die away. On the surface multicellular non-glandular hairs occur.

On the other hand, the anatomical structure of the runner-like part of the shoots deserves a fuller treatment. A diagrammatic transverse section is shown in Fig. 35, *B*; the thickly drawn line slightly within the periphery indicates a cork-layer, a portion of it is shown in Fig. 35, *C* under higher magnification. The outermost (uppermost) layer of cells in the latter figure, is the epidermis; this, together with the 2—3 outermost layers of the cortex, naturally dies away as

soon as cork-formation commences, yet how early in the development of the runner I am not prepared to state, but it probably happens rather early. The amount of cork developed is small; more than five layers of corky cells (the thin-walled elements placed in radial rows seen in the figure) never occur, in fact, often only 2—3 layers; sometimes the cortical layer situated immediately under the epidermis, forms the cork-cambium. This cork-formation is continued from the runner-like, into the rosette-bearing part of the shoot.

In the stele, which is surrounded by an endodermis of a similar kind as that of the root (in Fig. 35, *B* the innermost circle indicates the endodermis), two groups of xylem are found; the vessels are intermingled with non-lignified parenchyma, and the groups are separated by two broad medullary rays, diametrically opposite to each other, in the outer part of which a small group of narrow vessels occurs (leaf-traces). The pericycle is several-layered; like the cortex, it consists of cells with somewhat thickened walls. In the periphery of the xylem-groups a few wood-fibres sometimes occur.

The Leaf. The epidermis of the upper surface has lateral walls varying from straight to slightly undulating, comparatively thick, but only slightly porose; on the lower surface of the leaf the lateral walls of the epidermal cells are found to be slightly undulating; the cells are essentially more thin-walled than those of the upper surface. Stomata occur only on the lower surface of the leaf; they are surrounded by 4—9 cells.

A transverse section of the leaf is shown in Fig. 35, *E*; as far as I could judge from the material at my disposal, the portion which has been selected for illustration is typical: 2 layers of palisade-cells, and a few-layered spongy parenchyma with cells, which do not, on the whole, branch very copiously, are seen.

On the lower side of the leaf-lobes, glandular hairs of the usual *Pedicularis*-type are found, below the branches of the veins of higher order; the dense covering of non-glandular hairs on the lower surface of the leaf as well as on the leaf-stalk, is very characteristic of the species; the hairs (Fig. 35, *D*) are 2—5-celled, rather thick-walled, pointed and smooth, they are especially numerous below the branches of the veins of lower order, and along the leaf-margin, but are also found scattered here and there among the glandular hairs, and on the spaces between the veins. The epidermal cells from which they originate (Fig. 35, *D*) may be very thick-walled; they are often arched cupola-like.

Pedicularis hirsuta L.

Alcohol-material from numerous localities both in East and West Greenland, collected by E. Warming (11. 7. 1884), C. Ryder (11. 7. 1886 and 5. 7. 1887), S. Hansen (2. 7. 1888), N. Hartz (1. 9. 1891) and A. Lundager (29. 6. 1907, 17. 6. and 20. 6. 1908); also from Spitzbergen (Belsund, leg. Nathorst, 1. 7. 1888) and Norway (Talvik near Alten, leg. E. Warming, 17. 7. 1885).

Herbarium-material from Greenland, Ellesmere Land, Grant's Land, Spitzbergen, Nova Zembla and Northern Norway (Alten).

Lit.: Lange, 1871, pp. 253 et seq, 266, tab. III, fig. 21 (the seed); 1880, p. 76; 1887, p. 262; Nathorst, 1883, p. 10; Warming, 1886, pp. VII, VIII, 21, 44 and 54; 1888, pp. 35, 39, 59, 71, 74, 87, 97 and 103; 1890, pp. 206, 208 and 213; Rosenvinge, 1892, p. 686; 1896 (II), p. 78; Hartz, 1894, pp. 32 and 34; 1895 (I), pp. 116, 128, 167, 170, 171, 175, 225, 247 and 288; 1895 (II), pp. 335, 359 and 372; Hartz and Kruuse, 1911, pp. 339, 342, 343, 345, 347, 348, 353, 359, 364, 370, 375, 376, 378, 385, 402, 405, 409, 416, 418, 419, 423 and 428; Norman, 1895, p. 458; Ekstam, 1897, pp. 118, 168 and 180; 1899, pp. 7, 33, 37, 40, 48 and 50; Kruuse, 1898, pp. 350, 373, 380, 386, 394 and 398; 1905, p. 176; 1906, p. 249; 1911, in part IV pp. 196, 202, 244, 254, 266, 269 and 272, besides notes in the preceding parts;

Abromeit, 1899, p. 43; Knuth, 1899, p. 190; Andersson and Hesselman, 1901, p. 16; Cleve, 1901, pp. 10, 39, 57, 69, 70, 72, 76, 82, 83 and 88; Dusén, 1901, p. 39; Eastwood, 1902, p. 290; Porsild, 1902, pp. 110, 114, 124 and 216; 1910, pp. 259, 267 and 271; 1912, pp. 382 and 385; 1920, p. 143; Sylvén, 1905, p. 88; Simmons, 1906, p. 27, tab. II, figs. 7—8, tab. III, fig. 1; 1913, pp. 123, 137 and 164; Ostenfeld and Lundager, 1910, p. 31; Ostenfeld, 1915, p. 381; Lundager, 1917, pp. 360, 394, 399 and 402; Resvoll, 1917, p. 214.

Spot-bound, sympodial hemicryptophyte of semi-rosette type, with primary root of long duration, attaining as much as 2 cm in thickness and often furnished with some vigorous branches. As recorded by Th. Resvoll, in older specimens adventitious roots can be developed.

Sylvén describes only mere seedlings. The seed germinates in spring; during the summer a rosette consisting of a few small foliage-leaves, is formed, and the young plant enters upon its winter-rest with its shoot-apex protected by 4—6 bud-scales (Th. Resvoll): the following summer a rosette of more abundant leaves is formed, then again bud-scales and so on, until the time of flowering is reached. A flower-bearing shoot-portion with elongated internodes terminates the growth of the main axis. Also as Th. Resvoll remarks, during the flowering year, no rosette of radical leaves is formed. As regards the length of the first vegetative stage, the said author has found, that two-year-old plants had not yet any floral organs developed in the terminal bud.

At the rhizome-portion of the floral shoots, 1—3 innovation-shoots are developed — most frequently two; the succession of shoots with short internodes which are thereby formed, gradually brings about the formation of a "rhizoma multiceps" (a mesocorme).

The innovation-shoots pass through a vegetative-stage of two years duration before flowering; every summer, a rosette consisting of a few foliage-leaves, is formed and, as

in the main shoot, bud-scales, for the protection of the winter-buds. In the adventitious shoots, also, no rosette of fresh foliage-leaves occurs in the flowering year.

I have been so fortunate as to have Arctic material at my disposal, collected as late as on the 1st of September (Danmarks Ø, leg. HARTZ); it contained both buds which would flower next year, and also younger buds. The former were of a considerable size (1.5 cm long, 1 cm thick); ex-

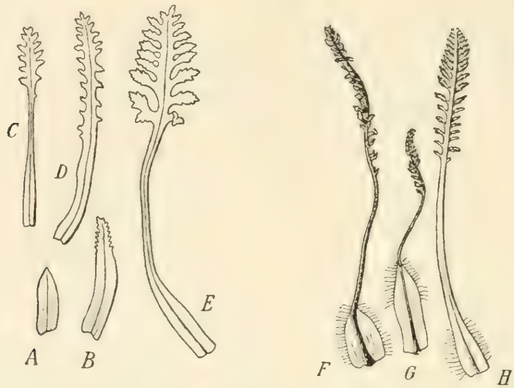


Fig. 36. *A—E, Pedicularis hirsuta.*
A, A bud-scale. *B*, Transitional form between bud-scale and foliage-leaf. *C* and *D*, Leaves from a part of the stem with elongated internodes. *E*, Rosette-leaf. (Greenland).
F—H, Pedicularis lanata.
F, A lower and *G* an upper leaf from the rosette of the same year. *H*, A leaf from the part of the stem with elongated internodes. (Greenland). All about nat. size.

ternally they were protected by the somewhat broadened bases of the dead leaves of the rosette, then followed 10—12 arched, pointed bud-scales, 10—13 mm long, and 5 mm broad, and hairy along their edges; the outermost of these bud-scales were withered. The young foliar organs were already large, and in the axils of the subtending-leaves of the inflorescence were floral buds about 0.5 mm in size, all enveloped

in non-glandular hairs. The purely vegetative buds were in all cases smaller, and the bud-scales fewer in number; also in them the young foliar organs were well-developed.

In Fig. 36 are shown 2 bud-scales (of which the one, *B*, was uppermost in a bud, and shows a rudimentary leaf-blade), a rosette-leaf and 2 leaves from the part of the shoot with elongated internodes (both kinds of foliage-leaves vary greatly in form). The leaves are hairy, especially at the base, and the stems also are abundantly covered with hairs, especially in the upper part.

The height of the flowering plant may vary greatly. From Spitzbergen (leg. TH. WULFF) I had specimens scarcely 2 cm high, which nevertheless bore as many as 4 flowers of normal size. It appears that during the end of the flowering period, a rather considerable elongation of the stem, especially of the upper part, takes place; two fruit-bearing specimens from Greenland (Amitasiarsak Fjord) were as much as 36 cm high.

The development of a "rhizoma multiceps" causes a somewhat tufted growth of the species. One specimen from Hvalrosodde (North-east Greenland, leg. ANDR. LUNDAGER) had at the same time as many as eleven flowering shoots, numerous leaf-rosettes and ten dead inflorescence-axes from previous years. This tuft-forming growth must afford additional protection to the winter-buds, the latter being covered by the numerous withered leaves.

Haustoria are found on the roots; according to ROSENVINGE this species is parasitic on *Vaccinium uliginosum* and *Salix herbacea*, for example.

In the fresh condition the root has a slightly yellowish colour, and a somewhat sweetish taste (NATHORST). The radiating clefts, which are formed in the tissue of the root,

especially in the cortex (see below), are, during the winter, found to be full of ice (M. Porsild, *in litt.*).

The structure of the flower will be evident from Fig. 37 (= Warming, 1886, fig. 12). *A* shows a flower seen from



Fig. 37. *Pedicularis hirsuta.*
A and *B* (the same flower) as well as *C—F* and *K—N* are drawn from Greenland material; *I* from a flower from Northern Norway (leg. Nyhuus), *O* and *P* from flowers from Spitzbergen (leg. Nathorst). (Cf. text.) (E. Warming, 1886.)

the side; *B* the same flower, and *K* another flower, both in front view: in *A* the densely hairy calyx should be noted, the short corolla-tube, the short, warty revolute portion of the edge of the upper lip and the ridge which passes downwards from its uppermost point, into the back of the corolla-tube; also the two convexities on the lower lip, and the

furrow between them; in *B* the slightly oblique lower lip should be noted and the wide slit (as much as 2 mm) between the two revolute portions of the edge of the upper lip: here the stigma protrudes just beyond the tip of the helmet. *C* shows the curving of the upper part of the style, in *E* is seen its natural and usual position in relation to the helmet and anthers. A flower of somewhat different structure is shown in *I*: there the style is shorter, less curved, and does not reach down underneath the anthers. *D* and *F* are opened anthers, *G* stigmatic papillæ and *H* germinating pollen-grains. Honey is secreted by the three-lobed swelling on the front of the oblique ovary (*P*).

Peloria may occur: such a flower is shown in *N*; there the corolla is irregularly 6-lobed, the stamens are of equal length, and the style protrudes far, and is erect.

In very small-flowered specimens brought by Nathorst from Spitzbergen, E. Warming found as close contact of stigma and anthers, as shown in *O*.

"The corolla is of a pale rose-colour, with darker throat and tip of helmet, more seldom the colour is pure white (for instance in Upernivik). The flower is set almost horizontally. The corolla-tube is . . . . 7—8 mm long; the total length of the flower is about 13—14 mm. Slight protogyny appears to occur, and the stigma probably protrudes somewhat more in the younger flowers than later on, so that cross-pollination may perhaps take place in these" (E. Warming, 1890, p. 213). According to information given by M. Porsild it is common in Northern Greenland for the corolla to be of a whitish shade or, at any rate, of a pale pink colour. Ekstam records this species from Nova Zembla as scentless, but from Spitzbergen, as having a strong perfume. Like all the species of *Pedicularis* mentioned here, it must be assumed originally to have been adapted to pollination by humble-

bees, but insect-visitors are rare in Greenland (M. PORSILD, *in litt.*), nor are they common in Northern Norway (EKSTAM, 1897, p. 175); from Spitzbergen humble-bees are absent (AURIVILLIUS). In spite of this, the species regularly sets fruit everywhere; it must also be said to be *the* one of the Arctic *Pedicularis spp.*, which is best fitted for self-pollination.

In flowers like *E* and *O* (less, it is true, in *I*) self-pollination is inevitable.

The seeds are described and figured in LANGE, 1871 (tab. III, fig. 21).

Geographical Distribution: West Greenland from 64° and northwards, rare between 64° and 68°; East Greenland from 65° and northwards (rare in the district of Angmagsalik); Arctic North America (the continent and the islands), Arctic Siberia and Russia, Nova Zembla and Spitzbergen, the mountain summits of northern Scandinavia.

In Greenland, according to the numerous records in the literature, it appears that the species makes no great demands as regards the nature of its habitat. Thus it can be found on heaths, mossy flats, herb-slopes, in coppices and in fissures in fields where the surface is cracked into polygonal cakes (rudemark) (LANGE, WARMING, HARTZ, KRUUSE and M. PORSILD), according to the last author also in gravelly barrens (1920, p. 143). In Greenland this species can dispense with a snow-covering during winter, and it is there a decided sun-plant, (M. PORSILD), and has not its proper home in the snow-troughs.

According to NORMAN, in Northern Norway it prefers gravelly, not grass-covered localities, and there it has not hitherto been found where the aspect is sunny, but only on the northern and indifferent (eastern and western) sides of the mountains; it belongs there to the flora of the snow-troughs (TH. RESVOLL). A. CLEVE also remarks: "Bedarf sehr wenig Insolation

und meidet sogar die sonnig trockene Wiese"; the species is otherwise characterized as "häufig in der Heide, insbesondere die frischere Andromeda-H., gern in schattigen, schneereichen Mulden, vom Plateau das Gebirge emporsteigend, Ferner in der Sumpfwiese und auf den Moorhümpelen, aber einerseits ins Moor nicht hinabsteigend, anderseits nicht auf trockener, vegetationsarmer Felsenflur. Ein verfilzter Humusboden ist unbedingt notvendig." In Greenland this species is a decidedly spring-flowering plant, but, as an exception, flowering specimens may be found throughout the summer according to the point of time at which the snow melts at the place in question. HARTZ found it on Danmarks Ø with the flowers still in bud on the 1st of September, and expressly remarks that it was "on quite recently-bared ground, at the foot of the snow-drift."

Anatomy. The Root. Fig. 38, *A* and *B*, shows portions of the transverse section of a root, about 4 mm thick. The epidermis decays very quickly — as described by HOVELACQUE for the root of *Pedicularis palustris* — the epidermal cells have already collapsed in roots not more than one mm in thickness, and in the root figured they have disappeared completely. The uppermost layer in Fig. 38, *A*, is the outermost layer of the primary cortex, which, on the whole, only consists of 4—5 cell-layers. The cells have been very greatly elongated tangentially during the secondary growth in thickness, and are divided by a great number of thin radial walls; the primary cortex persists for a long time, I found it even on roots about one cm thick. The outer walls of the outermost layer are cuticularised. At the stage of development figured in Fig. 38, an endodermis is not recognizable; in quite young roots faint Casparian dots can be demonstrated. The structure of the secondary cortex is very characteristic, since there is found in it a circle of radiating clefts, of which two

are seen in *B* (26 such clefts — most of them larger — occurred in the root figured) by which all the phloëm-tissue of secondary formation is split into a corresponding number of radii, which in their outermost parts appear to be somewhat crumpled together, evidently by pressure of the tissue later on formed by the cambium. In these radii the groups of sieve-tubes are flanked on both sides by parenchyma. Within the cambium some groups of vessels are seen; corresponding to each ray of tissue in the cortex 1 or 2 rays of groups of vessels occur in the xylem, divided reciprocally by broad radii of parenchyma, in which the clefts from the phloëm may be continued, and may reach almost to the centre of the root.



Fig. 38. *Pedicularis hirsuta.*
A, Transverse section of the outermost layers of the cortex of the root. *B*, Transverse section of a portion of the stele of the root. (Greenland.) (*A* and *B* about $^{110}/_{1}$.)

The portion of the stem with elongated internodes shows a thin-walled epidermis with stomata; the cortex is few-layered, and its cells contain chlorophyll-grains. When the

stem has reached its full development (i. e. at the end of the flowering period), there is found in the stele a continuous, but narrow ring of vessels and a few layers of wood-fibres, strengthened internally by the outermost layers of the pith,

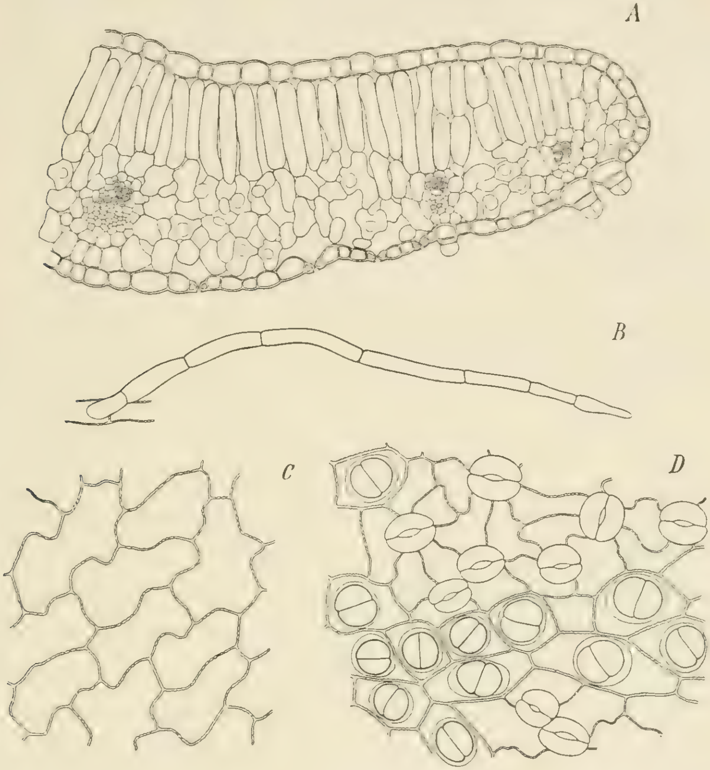


Fig. 39. *Pedicularis hirsuta.*
A, Transverse section of the leaf. *B*, A non-glandular hair from the basal portion of a leaf. *C*, Epidermis of the upper, and *D* of the lower surface of the leaf. (Greenland.) (*A* about $^{110}/_1$; *B* about $^{70}/_1$; *C* and *D* about $^{220}/_1$.)

the cell-walls of which become somewhat thickened and lignified; the central part of the pith dies away. In the basal part of the stem which bears the leaf-rosettes (the mesocorme), a transverse section shows a circle of vascular bundles with

intervening parenchyma-rays. Secondary growth in thickness takes place, and in connection with this a similar cleft-formation in the phloëm as in that of the root. The pith is wide, and does not die away.

The Leaf. The epidermal cells of both the upper and lower surface have thin, finely porose and almost straight to slightly wavy lateral walls (Fig. 39, *C* and *D*). Stomata occur only on the lower surface; they are surrounded by 4—6 cells. The transverse section shows 1—2 layers of well-developed palisades and a spongy tissue consisting in part of rather copiously branching cells (Fig. 39, *A*). Non-glandular hairs of the type shown in Fig. 39, *B* occur both on the stem and leaf; they are found in particularly great numbers on the basal portions of the foliage-leaves of the portion of the stem with elongated internodes, and on the leaves subtending the flowers, but more sparingly on the basal portion of the rosette-leaves proper, and only singly on the leaf-lobes, and then always on the upper surface. On the epidermis of the lower surface, under the branches of the veins of higher order, glandular hairs of the usual type are found; the epidermal cells upon which the glandular hairs are seated, have straighter, thicker and more highly porose lateral walls, than have those which surround them.

Chlorophyll was present in abundance in the whole of the mesophyll and was also found in the epidermis of the lower surface.

No difference could be observed as regards the anatomical structure of the leaves of the rosette and of those on the portion of the stem with elongated internodes.

Pedicularis lanata (Willd.) Cham. & Schlecht.

Alcohol-material from Greenland (Amerdlok, 15. 7. 1884, leg. Th. Holm; Kingartak, 25. 7. 86, leg. Ryder; Pröven, 24. 6. 1888, leg. Myhre).

Herbarium-material from Greenland, King William's Land, Ellesmere Land, Arctic North America, Nova Zembla and Arctic Siberia.

Lit.: Lange, 1880, p. 76; 1887, p. 262; Nathorst, 1883, p. 10; Warming, 1886, pp. VII, VIII, 21, 44, 47 and 54; 1888, pp. 59, 74, 87 and 104; 1890, pp. 206, 208, 210 and 213; Rosenvinge, 1892, p. 687; 1896 (I), p. 68; Hartz, 1894, p. 45; 1895 (I) p. 306; 1895 (II), p. 372; Kruuse, 1898, pp. 350, 373, 380, 394 and 398; 1906, p. 249; 1911, pp. 103, 132, 196 and 207; Abromeit, 1899, p. 44; Ekstam, 1899, pp. 7, 32, 37, 40, 48, 49 and 50; Knuth, 1899, p. 193; Andersson and Hesselman, 1901, p. 16; Eastwood, 1902, p. 291; Porsild, 1902, pp. 114, 178; 1910, pp. 259, 267 and 270; 1912, pp. 382 and 385; 1920, p. 143; Simmons, 1902, p. 29, tab. II, figs. 1—3; 1906, pp. 124, 137 and 164.

Spot-bound, sympodial hemicryptophyte of the semi-rosette type; like the foregoing closely related species, it has a thick, scantily branched main root of long duration; adventitious roots are probably, as a rule, only slightly developed. As *P. hirsuta*, this species can form large and dense tufts.

It appears that the first vegetative-stage may be confined to two years, so that the main axis of the young plant, after the formation of two consecutive leaf-rosettes, can, in the third summer, form a shoot-portion with elongated internodes, although a comparatively weak one, terminating in an inflorescence. Generally, the necessary vegetative-stage preceding the flowering is, no doubt, of longer duration. The vegetative stage of the innovation-shoots extends as a rule over 2 years.

P. hirsuta and *P. lanata* differ essentially from each other by the fact that the latter has no specially-developed

bud-scales, but protects its young buds during the winter with the broad, arched, very persistent bases of the rosette-leaves developed during the growth-period of the preceding summer, which bases are densely hairy along their edges; the rosette-leaves formed towards the end of the growth-period, are especially distinguished by their large basal-portions. Fig. 36, *G* shows such a leaf. On the other hand, the stalk and blade of the leaf illustrated in Fig. 36, *G* are essentially smaller than those in Fig. 36, *F*, which is a previously developed leaf from the same rosette; the leaf-blade may be even smaller than in *G*, but I do not think it is ever wholly wanting.

The leaves upon the uppermost portion of the shoots where the internodes become elongated, have not such broad bases (Fig. 36, *H*).

The rosettes are rich in leaves; at the base of a fairly vigorous flowering shoot I counted 60 withered leaves or remnants of such; also the above-ground portion of the stem is abundantly covered with leaves, especially below, although it cannot be said that the shoots have any true radical rosette of fresh leaves in the flowering year. The rosette-leaves, when withered, are very persistent, and may remain for several years, black and crumpled, at the base of the shoots (Fig. 36, *F* and *G* are two such withered leaves); naturally, this contributes towards making the tufts denser, and the protection of the young buds more effective.

The root is intensely yellow in colour, and has, as already stated by Nathorst, a sweetish taste, almost like that of carrots. It is used as an article of food by the Smith-Sound Eskimos[1] and by the Chuckes (Kjellman, 1882 (III), p. 366).

The structure of the flower is shown in Fig. 40, *A*—*D*

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[1] P. Freuchen: Om Plantekost hos Smith-Sund Eskimoerne. Geografisk Tidsskrift. Kjöbenhavn. Bd. 24. 1917—18. p. 310.

(the drawing is executed after a sketch by EUG. WARMING made from material from Greenland). In *A* and *B* the flower is seen from the side, the position of the stamens is indicated in *A*; in *B* the ridge reaches highest above the uppermost edge of the revolute portion of the margin of the upper lip; of the three lobes of the lower lip, the middle one is the smallest. The lower lip is not oblique; the two convexities are quite glabrous. *C* shows a flower in front view, the narrow furrow between the convexities should be noted. *D*, a pair of stamens; here the filaments of both stamens are hairy; this feature varies, sometimes only the two longest are hairy. In this species also there occur nectary-protuberances at the base of the ovary.

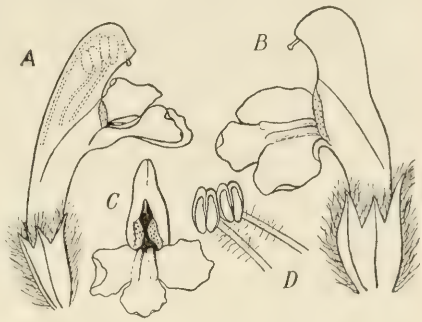


Fig. 40. *Pedicularis lanata.* *A* and *B*, Flowers seen in side view; in *A* the position of the anthers and the style is indicated; the hairs of the calyx are drawn only along the outlines of the figures. *C*, The uppermost part of a flower in front view. *D*, A pair of anthers. (Greenland.) (*A*, *B* and *C* about $^2/_1$; *D* about $^5/_2$.) (After E. WARMING.)

"This species is still more conspicuous (than *P. flammea* and *hirsuta*) on account of its richly and densely flowering inflorescence, and the bright pink colour of the flowers; the tip of the upper lip and the throat are darker in colour than the rest of the flower. It has also a slight scent, and the flowers are considerably larger than those of the two foregoing species (*P. flammea* and *hirsuta*), having, namely, a total length of 2 cm, and a corolla-tube-length of 12—13 mm . . . . The flower stretches out considerably, it may even be almost horizontal. The stigma projects out of the flower,

and will evidently be easily touched by an insect visitor. the anthers are placed immediately behind the stigma and, on account of the stretched-out position of the flower, partly above it, so that self-pollination will probably take place" (E. WARMING, 1890, p. 213). The same author describes a flower from Spitzbergen with pelorial development.

On Spitzbergen (forma *dasyantha*) EKSTAM found the end of the style to be rolled up (as in *P. hirsuta*, cf. Fig. 37), so that the stigma is in contact with the anthers. In my material I always found it to be protruding, as also shown in the figure.

Varieties with entirely white flowers may occur, but they are very rare (M. PORSILD, 1920).

The species is fragrant (EKSTAM and WARMING). It sets fruit everywhere abundantly and regularly, and also in Spitzbergen, where humble-bees, its natural pollinators, are wanting (AURIVILLIUS); according to information given by M. PORSILD, insect-visitors are rare in Greenland. Among the Eskimos the plant is known for the abundance of honey contained in its flowers; at Cape York its popular name is: "The food of the humble-bees;" and children pick the flowers and suck the honey out of them or even eat them entire (FREUCHEN, l. c.).

During the end of the flowering-period, the axis of the inflorescence elongates.

Geographical Distribution. The species is common in West Greenland, from Disco Bay and northwards. "In N. Strömfjord it is restricted to alpine stations and northern slopes and rather scarce (P & E). South of Holsteinsborg observed several times down to Itivdlinguaq, 66° 30′ (P & E)" (PORSILD, 1920); from East Greenland it is totally absent (PORSILD, l. c.). It is also found in Arctic North America (the continent and the islands), the western Subarctic North

America, (the Rocky mountains), Arctic Asia, Nova Zembla and Spitzbergen. The species prefers fairly dry habitats. M. PORSILD records that it is found "on rocky flats and on heaths" (1912, p. 382). "In poor and open heath, often in gravelly barrens far away from other plants. When growing

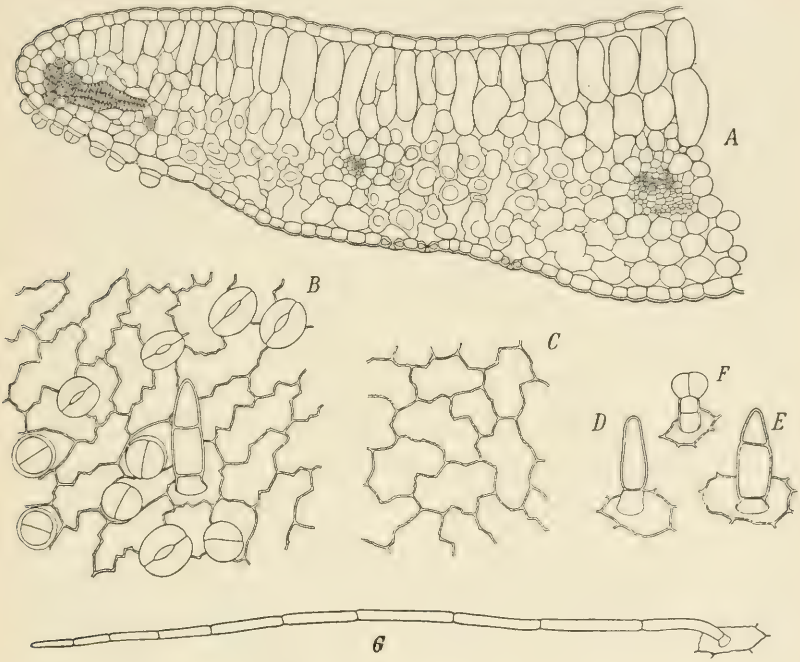


Fig. 41. *Pedicularis lanata.*
A, Transverse section of the leaf. *B*, Epidermis of the lower, and *C* of the upper surface of the leaf. *D* and *E*, Non-glandular hairs from the lower surface of the leaf. *F*, A glandular hair from the stem. *G*, A non-glandular hair from the basal portion of leaf. (Greenland.) (*A* about $^{110}/_{1}$; *B*, *C*, *D*, *E* and *F* about $^{220}/_{1}$; *G* about $^{70}/_{1}$.)

amongst other plants, however, the roots also of this species are provided with *haustoria*" (1920, p. 143). During the winter, although the plants in themselves are often bare of snow (l. c.), yet the dense tufts always catch some snow between the numerous decaying leaves, and this naturally

affords some protection to the winter-buds (M. PORSILD *in litt.*). According to the same author, in the same locality, the species flowers 1—2 weeks before *P. hirsuta* (1920, p. 143). On Spitzbergen, according to EKSTAM, it is found "auf trockenen, starker Insolation ausgesetzten Abhängen."

In anatomical respects, the root and stem agree closely with the corresponding organs in *P. hirsuta.* The anatomy of the leaf is shown in Fig. 41, *A*—*G*. In the transverse section 1—2 layers of short and broad palisade-cells are seen, and a spongy parenchyma, which consists of distinctly branched cells. *B* shows a portion of the epidermis of the lower surface, and *C* a similar portion from the upper surface of the leaf. The lateral walls are thin and finely porose; stomata are found only on the lower surface of the leaf and the guard-cells occur on a level with the leaf-surface. On the basal portion of the leaf, the cuticle is thicker than on the stalk and the lobes, and it is furnished with fine striations. Chlorophyll occur in abundance in the mesophyll, and also in the epidermis of the lower surface.

The glandular hairs in this species are almost exclusively confined to the edges of the leaf-sections; in *A* is seen exteriorly to the left, a group of the tracheidal tissue in which the branches of the veins end, and in connection with which the glandular hairs occur. The structure of these is similar to that in the other species; the epidermal cell from which the glandular hair is developed, has not, however, in *P. lanata*, much thicker or more highly porose walls, than have the epidermal cells, which surround it. Non-glandular hairs of the type shown in *G* occur in abundance on the edges of the leaf-bases, on the stem and, in the floral region, on the scale-leaves and calyx, more scantily on the leaf-stalk, and on the upper surface of the leaf-blade. On the lower side of the leaf-lobes there are small non-glandular

hairs (Fig. 41, *B*, *D* and *E*) intermingled with the glandular hairs; on the petiole and stem are glandular hairs of the form shown in Fig. 41, *F*.

Pedicularis flammea L.

Alcohol-material from Greenland (Godthaab, leg. E. Warming, 29. 6. 1884; Christianshaab, leg. S. Hansen, 2. 7. 1888; Prøven, leg. Myhre, 2. 7. 1888; Danmarks Ø, leg. N. Hartz, 18. 2. 1892), Iceland (Hvitarvattn, leg. A. Feddersen, 3. 6. 1886), and Northern Norway (leg. Nyhuus, 1885).

Herbarium-material from numerous places in East and West Greenland, from Norway, Iceland and Arctic America.

Lit.: Lange, 1870, pp. 254 et seq., 266, tab. III, fig. 22 (the seed); 1880, p. 75; 1887, p. 262; Warming, 1886, pp. VII, VIII, 44, 47 and 54; 1888, pp. 27, 34, 39, 59, 87, 90, 104, 130 and 133; 1890, pp. 207, 208 and 211; Rosenvinge, 1892, p. 686, 1896 (II), p. 128; Hartz, 1894, pp. 11, 32 and 43; 1895 (I), pp. 165, 170, 171, 175, 188, 247, 256, 288 and 290; 1895 (II), pp. 335, 359 and 372; Hartz and Kruuse, 1911, pp. 338, 342, 347, 357, 359, 378, 379, 380, 385, 409, 411, 423 and 428; Børgesen, 1895, pp. 223 and 225; Norman, 1895, p. 458; Kruuse, 1898, pp. 350, 373, 379, 394 and 398; 1905, p. 176; 1906, p. 248; 1911, in part IV pp. 196, 243, 254, 255 and 274 besides notes in the preceding parts; Abromeit, 1899, p. 43; Knuth, 1899, p. 190; Cleve, 1901, pp. 18, 39, 57, 72, 76 and 88; Dusén, 1901, p. 39; Porsild, 1902, pp. 114, 175, 178, 187, 216; 1910, p. 267; 1912, pp. 382 and 387; 1920, p. 142; Ostenfeld and Lundager, 1910, p. 31; Simmons, 1913, pp. 124 and 140.

Spot-bound, sympodial semi-rosette hemicryptophyte, with short, vertical mesocorme which dies away behind, and a rather abundant development of adventitious roots.

The first vegetative-stage fairly commonly appears to extend over 4 years — in the case of one individual (Disco) I found it to extend over 3 years, and in the case of another (Iceland) 6 years. A short, vertical mesocorme is developed during the first vegetative stage; the main root is still present during the first flowering-period, but dies away afterwards.

The winter-buds are provided with a number of bud-scales; these as well as the foliage-leaves leave real leaf-scars on the mesocorme on decaying. Adventitious roots are developed rather abundantly, especially from the basal part of the mesocorme, they generally occur in connection with innovation buds; the adventitious roots are somewhat swollen.

The innovation-buds arise from the axils of the scale-leaves; the lower buds on the mesocorme do not generally develop any further, but remain as reserve-buds; as in *P. Oederi* it is the buds which occur in the axils of the innermost scale-leaves formed during the summer previous to that in which the parent-shoot flowered, which are the most vigorously developed. Usually only two of these buds expand, but the number may be more, in a single case I counted as many as 6.

During their first summer the adventitious-shoots always bear two fully-expanded foliage-leaves; as in the main-shoot the terminal bud is protected by scale-leaves. In case flowering does not take place in the following year, — it may occur, but no doubt only exceptionally, — a rosette of foliage-leaves is developed, followed in turn by scale-leaves, and then, after passing through still another winter the shoot, in the majority of cases, succeeds in flowering.

In a specimen from Ignerit (Greenland) in which 2 of the basal buds on the mesocorme had developed further, one of them had formed rosettes of foliage-leaves for 4 successive summers, and the other for even 5.

In a winter-bud (the specimen in question was collected by N. Hartz, on the 18th of February 1892, on Danmarks Ø, East Greenland) there were found young foliar organs and flowers, all of which were highly developed; in the young flowers the separate parts were quite distinguishable

under the microscope. The shoot which was terminated by this winter-bud, was one year old — consequently, the length of the purely vegetative period in this case will only have been one year — during the previous year it had, as is usually the case, unfolded 2 foliage-leaves; the bud-scales numbered 5.

The maximum height of the flower-bearing shoot was found to be 28 cm; from Iceland and Greenland I found small individuals, flowering for the first time, which were only 3 cm high. A specimen from Disco differed entirely by a total absence of foliage-leaves on the above-ground stem, which was 20 cm high, and by having flowers, the lowermost of which were long-stalked almost down to the base; the axis was comparatively very thick (about 8 mm in diameter).

E. Warming found the flowers from Norway (W. Finmark), Iceland and Greenland to agree entirely in structure; from his descriptions I quote the following: "The flowers are not very conspicuous; their lower part stands erect, almost parallel with the axis of the inflorescence, their upper part is bent slightly forward (Fig. 42, *A*); the colour is yellow, the upper part of the helmet is, however, more or less reddish-brown. The corolla-tube is only 7—8 mm long; the lower lip is very small, with three rounded lobes, and often appears smaller still by the fact of its edges being bent backwards (Fig. 42, *C*). The cleft of the upper lip is sometimes very narrow ($^1/_2$ mm, see Fig. 42, *D*), but sometimes wider, even so wide that there is a large entrance to the interior of the flower, as for example in flowers with an upper lip curved strongly forward.

This species appears to be as highly adapted to self-pollination, as it is poorly adapted to insect-pollination, which also agrees with the fact that it is so little conspicuous. I never saw the stigma protrude from the blunt, untoothed tip; so it is placed immediately in front of, or slightly under

the anthers (Fig. 42, *F*). The fact that in many flowers I have found the stigma covered with pollen-grains, some of which were germinating, and have found abundance of pollen around the anthers, even in a flower like *A—B*, in which the stigma is situated so unusually high above the anthers, is a justification for regarding this as brought about by self-pollination. I must, however, point out the fact that the

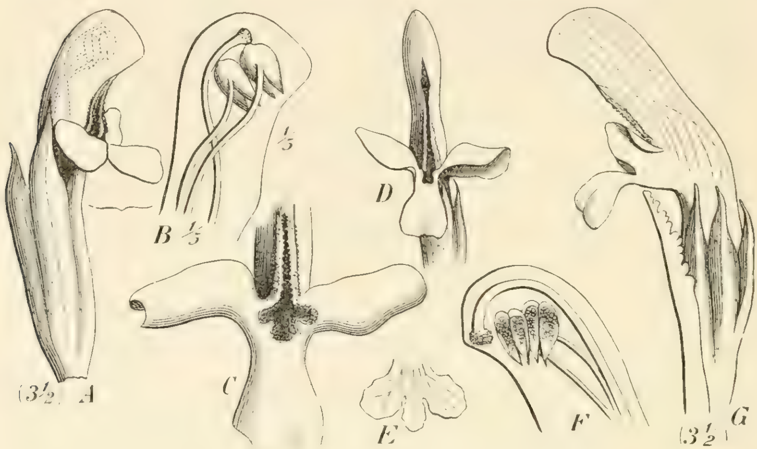


Fig. 42. *Pedicularis flammea.* (Greenland).
A, A flower in natural position in the inflorescence; *B* ($^5/_1$), the upper part of the same in longitudinal section. *C*, Lower lip and the part around the throat seen in front view. *D*, The upper part of a flower in front view. *E*, Lower lip, slightly magnified. *F* as *B*, but with the stigma in another position. *G*, A flower in natural position, larger than *A*, showing the venation of the upper lip. (E. WARMING, 1890.)

stigma is not placed in the same position relative to the anthers in all the flowers of the same inflorescence, and it appeared to me to be the rule for it to be situated slightly more forward in younger than in older flowers; . . . . the filaments are glabrous. In many places in West Greenland, as far as Upernivik (RYDER), it was found with abundant fruit. Even in July (1884) new fruit was set at 64° and 67° N. lat."

I can add to the above that in older flowers the helmet often appears to bend forward, as described by Kerner in the case of *P. Oederi*.

In the material at my disposal, both from West and East Greenland, there were many fruiting specimens. That it really is the rule for the stigma to be enclosed in the helmet, is seen among other things, by the fact that Blytt in his "Haandbog i Norges Flora" gives this as a specific character.

Geographical Distribution: West and East Greenland (rare in South-west Greenland according to Rosenvinge, in East Greenland even as far north as Germania Land according to Ostenfeld and Lundager), Iceland, Arctic and Subarctic North America, Arctic Russia and the mountainous regions of Northern Scandinavia.

As regards the habitat of *P. flammea*, many notes are to be found scattered in the literature on the subject. A. Cleve states that in the district of Northern Sweden investigated by her, it was found "nur auf den Moorhügeln und in Sumpwiesen zusammen mit der vorigen (*P. hirsuta*), welche diese Art nicht bis in die trockene Heide zu begleiten vermag, ebensowenig wird sie auf dem N. Abhang oder in der Nähe von spät schmelzendem Schnee gefunden." In Northern Norway it is found, according to Norman, only on the northern and on the indifferent (eastern and western) sides of the mountains. In West Greenland it grows, according to E. Warming, in willow-coppices where it may be said to have its home, and also on herb-flats, on heaths (parasitically on *Vaccinum uliginosum* and *Salix herbacea*) and in grassy bogs. Porsild has also found it on slightly damp moss-heaths. N. Hartz and Kruuse record it from East Greenland as growing on herb-slopes and rocky flats, in carpets of prostrate *Betula nana* and *Vaccinium uliginosum*, on knolls in bogs, and on damp heaths. According to Hartz

(1895 (II), p. 335), its habitat is snow-covered during winter; the plant is mentioned as common in the interior of the fjords, but absent further eastwards, out towards the open ea. Dusén records practically the same, and he also knows it only from a single habitat in the coast-land outside the fjords (Cape Borlase Warren). A. Cleve considers it to belong to the "Gruppe der späteren Frühlingspflanzen." In Greenland it is a middle-summer-flowering plant (M. Porsild).

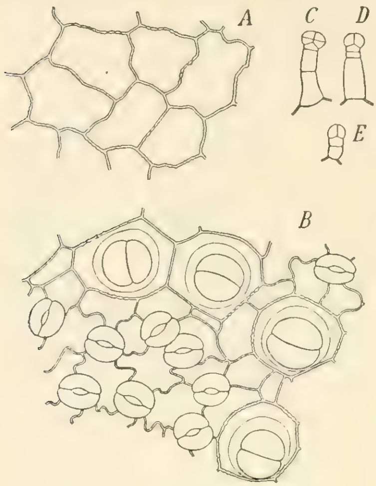


Fig. 43. *Pedicularis flammea.* *A*, Epidermis of the upper surface of the leaf; *B*, of the lower surface of the leaf. *C*, *D* and *E*, Glandular hairs; *C* and *D* from the upper surface and *E* from the lower surface of the leaf. (Greenland.) (*A* and *B* about $^{220}/_{1}$; *C*, *D* and *E* about $^{70}/_{1}$.)

The Anatomy of the root and stem agrees exactly with that of the corresponding organs in *P. Oederi.* The parenchyma of the root contained a great abundance of amylodextrin-starch.

The surface-view of upper and lower epidermis of the leaf is shown in Fig. 43, *A* and *B*; the pores of the lateral walls were always found to be rather faint. The transverse section of the leaf agrees exactly with that of *P. Oederi.* Non-glandular hairs are absent; in addition to the glandular hairs of the usual *Pedicularis*-type, such forms are also found as are shown in Fig. 43, *C*, *D* and *E*; *C* and *D* occur scattered, especially on the upper surface of the leaf, and *E* on the lower surface of the segments, especially along their main vein and lateral veins

of 1st order. Chlorophyll-grains occur abundantly in the whole of the mesophyll, and also in the epidermis of the lower surface.

Pedicularis Oederi Vahl.

Alcohol-material from Norway (Kongsvold (Dovre), leg. E. Warming, 13. 7. 1887; Muggrubfjældet near Røraas, leg. Thekla Resvoll, 29. 7. 1918).

Herbarium-material from Nova Zembla, Arctic Siberia (Khabarowa and from near the Taimyr river) and St. Lawrence Island.

Lit.: Axell, 1869, p. 102; Kjellman, 1882 (I), p. 257; 1882 (II), p. 325; 1882 (IV), p. 510; Kjellman and Lundström, 1882, p. 304; Aurivillius, 1883, p. 451; Warming, 1886, p. 47; 1890, pp. 207, 208, 210 and 214; Lindman, 1887, pp. 82 and 99, tab. IV, fig. 46; Kerner, Bd. II, 1898, p. 337; Knuth, 1899, p. 186; Sylvén, 1906, p. 89; Schröter, 1908, pp. 454, 455 and 458; Resvoll, 1917, p. 210.

Spot-bound, sympodial semi-rosette hemicryptophyte with a short, vertical mesocorme which dies away behind. Adventitious roots are rather abundantly developed.

According to Sylvén the seed germinates in spring. "The elongated hypocotyl unites with the main root, scantily branched throughout, into a peg-shaped food-storing organ which becomes rather thick at an early period. In more advanced young-plants adventitious roots, thickened by the storage of reserve food-material, like the main root, sometimes appear to be developed from the hypocotyl, or from the base of the epicotyl." Th. Resvoll has studied the whole development from seed to flowering plant: During the first summer two small foliage-leaves expanded, the terminal bud was protected by a few scale-leaves, and contained the rudiments of the foliage-leaves of the following summer; the plant passed the winter in this stage. The foliage-leaves fell off late in autumn, and left leaf-scars. "After having passed

through the winter, the young leaf-organs developed into a rosette of foliage-leaves, few in number, . . . even early in the summer the development of foliage-leaves stopped, instead of which the apex of the stem developed a terminal bud covered with scales. In this manner the plant continues through several years. The leaves, which are exceedingly small in the first summer, having blades only about 1 cm long, become larger every summer, and the number of the leaves also increases with the age of the leaf-rosette. The last summer before the plant flowers I have seen 4—8 foliage-leaves."

The shortest first-vegetative-stage observed by the author in question, extended over 3 summers, in other individuals it proved to have extended over as many as 6 summers; in one individual (from Nova Zembla) I found 3 vegetative years, another showed 7. As the leaves fall off, leaving a regular leaf-scar (as already described by E. WARMING (1890, pp. 207 and 209) both for this species and for *Pedicularis palustris*) and the broader and more distantly-placed scars of the foliage-leaves can be easily distinguished from the narrower and more closely-placed scars of the scale-leaves, the individual year-growths of the mesocorme become very marked and easily observable (TH. RESVOLL).

"It is characteristic of this plant, that the development takes place, so to speak, suddenly, as long as the plant is in the rosette-stage. Thus all the leaves come out almost at once, and not one by one during the summer; and as soon as the rosette has unfolded, the bud for the next summer is already seen in the middle of it. The same is also the case as regards the rosette-stage of the lateral shoots." (TH. RESVOLL).

Even in the bud, the rudiments of the organs which are to expand during the next summer, attain a high degree of development. In an individual which TH. RESVOLL in-

vestigated on Knutshø (Dovre) on July 23rd, the terminal bud proved to contain "the young stem for the coming summer, covered by the rudiments of the stem-leaves; within these were the subtending leaves of the flowers; the separate parts of these were already distinctly discernable."

The flower-bearing stem-portion has, as a rule, no foliage-leaves at its base, but such may occur as an exception.

In the interval between germination and flowering the plant develops a vertical mesocorme, as much as 1 cm long and 0.5 cm thick, from the lower part of which there proceed a varying number of adventitious roots (I counted as many as 8); as in *P. flammea* they are somewhat swollen, as a rule especially in their proximal half, but sometimes also along their entire length, but narrowing abruptly towards the base; they become as much as 10 cm long, and as much as 6 mm in diameter; most frequently they are furnished with slender, filiform branches, or, at any rate, scars left by such are present; more rarely with 1—2 vigorous root-branches. The main root dies away; in the majority of cases it probably does not survive the first flowering period of the individual. As mentioned by Warming (1890, p. 207), the majority of the adventitious roots arise at the base of a bud on the mesocorme. According to the observations of Warming and Th. Resvoll — which observations I am able to confirm fully — the lateral buds are developed especially in the axils of the scale-leaves, and are of the same age as these. The buds in the lower part of the stem develop two small foliage-leaves during their first summer, but usually do not develop any further; as a rule they are found as small formations covered with a few scale-leaves; they must be regarded as reserve-buds, for, as seen in a specimen from Nova Zembla, under certain circumstances they may develop further and even produce flowers.

The most fully developed buds are always found (TH. RESVOLL) in the axils of the uppermost set of scale-leaves, which are found to the number of 5—10 at the base of the flower-bearing stem-portion. It is commonly the innermost scale-leaves which subtend the innovation buds, and usually only two such are found, more rarely several (as many as 7, TH. RESVOLL). During their first summer they develop 2—3 rather large foliage-leaves, often followed by 1—2 quite small ones, and lastly bud-scales for the protection of the winter-bud. The buds open almost at the same time as the flowers of the main shoot.

According to TH. RESVOLL, the duration of the vegetative-stage of the lateral shoots may be restricted to one year only; it is, however, longer, as a rule; for instance, on Knutshö (Dovre) the said author found 4-year-old lateral shoots, which had not as yet young floral organs in the terminal bud. In several cases also I found a vegetative stage of only one year's duration (among others in a specimen from Nova Zembla), more frequently, however, 2 or 3 years.

As the parent-rhizome dies away behind, and the lateral shoots develop adventitious roots, there is a possibility of vegetative propagation, although, of course, the plant cannot spread much by this means.

SCHRÖTER records this species from the Alps as occurring parasitically especially on *Carex firma.*

The structure and biology of the flower was first described by LINDMAN; since that E. WARMING and KERNER have dealt with this species. Some unpublished drawings of the flower have been kindly placed at my disposal by E. WARMING; the illustrations in Fig. 44, with the exception of *G* and *H*, have been made after them. *A* is characterized by its long corolla-tube, its densely-hairy calyx, (the hairs have been indicated only along the edge of the calyx),

and by its but slightly protruding stigma; in *B* the main features of the venation of the helmet are seen, to which a system of raised ridges on the outer side of the helmet corresponds. The dots on the side of the helmet in Fig. 44, *B* indicate small glandular hairs, which are especially numerous in the front part of the helmet. Fig. 44, *H* shows such glandular hair in lateral view, highly magnified; the head is 4-celled. *D* is the lower lip in surface view; the two con-

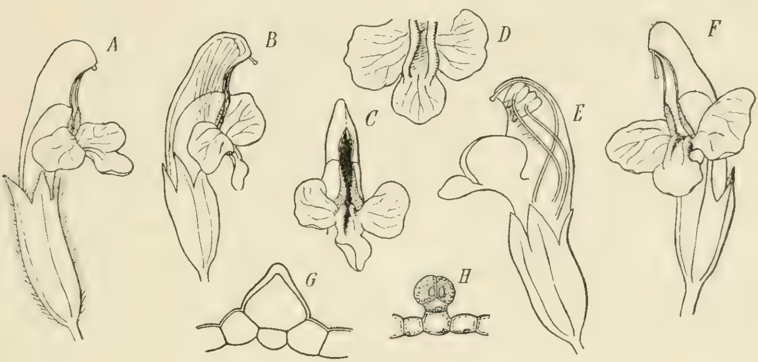


Fig. 44. *Pedicularis Oederi.*
A, *B*, *C*, *D* and *E* are drawn from flowers from Sweden; *F* is a flower from Kongsvold (Dovre). *G*, Transverse section of one of the warts from the revolute portion of the edge of the upper lip. *H*, A glandular hair from the helmet. (*A*, *B*, *C*, *D*, *E* and *F* slightly under $^2/_1$; *G* and *H* about $^{110}/_1$.) (Drawn by E. Warming.)

vexities are distinctly visible here, as also in Fig. 44, *C* and *F*. Fig. 44, *F* shows a flower with a very far-protruding style; in *E* the position of the stamens is seen, the filaments of the foremost pair of stamens are hairy along their upper part. One of the warts from the revolute portion of the upper lip is seen under high magnifying power in Fig. 44, *G*; on its outer surface it has strong cuticular striations, as have also the cells which surround it. The calyx, subtending leaf and axis of the inflorescence vary from glabrous to

hairy, even in individuals from the same locality (Muggrub-fjældet near Röraas); the hairs are multicellular, pointed and glabrous.

I quote the following from LINDMAN's exhaustive description:— "The flower is 20 mm long, yellow or whitish-yellow in colour; the tip of the upper lip is dark-red on its inner side, and this colour more or less penetrates through and gives the corresponding spot on the outer side a greyish-red tint; the upper lip has often in addition on the outer side a dark-red spot on each side. The flower is quite erect and adpressed to the peduncle. . . . The stamens agree with those in the other species; their pollen is consequently dry and loose, is fully developed even in the flower-bud, and is contained in a receptacle formed by the four convergently dehiscing anthers, which are held together by the laterally highly compressed upper lip. . . . As in the other species the pollen is shed when an insect penetrates into the flower, and thereby widens the slit of the upper lip, which is rather narrow in this species. . . . The nectary is in the same place as in the other species; the corolla-tube is 10—13 mm high." The position of the stigma in the flowers figured by LINDMAN is very much like that in Fig. 44, *B* and *F*, given here; in addition LINDMAN mentions flowers in which the style was so short, that the stigma remained quite inside the helmet, and did not even reach the anthers; the stigma was normally developed, however, in these flowers.

According to KERNER (p. 337) the whole of the upper lip curves forward so strongly at the end of the flowering period, that it looks as if it were broken; even if it originally stood as a continuation of the lower part of the corolla-tube enclosed in the calyx, it stands then at an angle of 70°, or even 90° with this, and by bending forward it drags down with it the style and the stamens, so that the stigma no

longer stands in front of, but below the anthers; these are no longer united, and shed their pollen spontaneously, which is scattered down upon the stigma, and effects self-pollination in case cross-pollination should fail. LINDMAN and WARMING mention nothing regarding this point; I observed it in many inflorescences but must, however, add that the curvature may also take place in the uppermost part of the corolla-tube.

KERNER (Die Schutzmittel der Blüthen gegen unberufene Gäste, 1876) and after him H. MÜLLER, describes the pollination of *P. recutita*, a species very similar to the present one, and, in so doing, states that the insect (humble-bee) on its visit thrusts its proboscis into the narrow furrow between the two convexities on the lower lip, and forces these and the edges of the slit of the upper lip apart from each other; while LINDMAN maintains that the furrow in *P. recutita* is too narrow an opening for the introduction of the proboscis of the humble-bee, as this is not even possible in the larger-flowered *P. Oederi*, where the proboscis can only be thrust in higher up, at about the middle of the revolute portions of the edges of the upper lip ("die Rolle"). Visitors: LINDMAN observed *Bombus nivalis* and *Bombus alpinus*; AURIVILLIUS mentions frequent visits of humble-bees.

According to WARMING, fruit is set abundantly in Scandinavia.

Geographical Distribution. In the Carpathians and the Alps ("ganze nördliche Kette von St. Gallen bis Waadt — fehlt den Centralalpen," SCHRÖTER), the mountainous districts of Scandinavia, Arctic Russia and Siberia (recorded by KJELLMAN from several localities along the north coast of Siberia), Nova Zembla, Central Asia and the mountainous districts of East Asia.

Habitat: BLYTT (Håndbog i Norges Flora) records

"boggy places in mountainous districts, ... from the birch-zone up to the lichen-zone; more rare below the pine-limit"; Th. Resvoll has now and then observed it in snow-troughs; it is, however, no typical snow-trough-plant. It does not ascend very high in the Alps; Schröter (p. 255) mentions it as occurring in the transition-zone between his Agrostidetum-trifolietum and Curvuletum (*Carex-curvula*-assoc.). In Arctic Eastern Asia Kjellman found it growing on damp coastal plains.

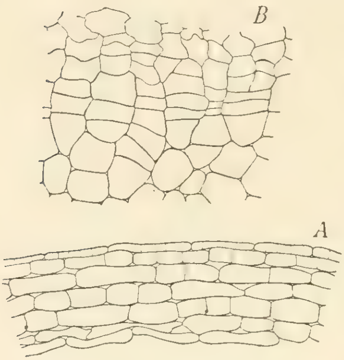


Fig. 45. *Pedicularis Oederi.* *A*, Transverse section of the peripheral layers of the root. *B*, Section through a leaf-scar. (*A* about $^{70}/_{1}$; *B* about $^{140}/_{1}$.)

Anatomy. In anatomical respects the root very much resembles that of *P. hirsuta*, the radiating cleft-formation in the stele — at any rate in the adventitious roots, which are the only ones that have been investigated — is not, however, so decided as in *P. hirsuta*.

The epidermis decays early; during growth the cells of the cortex are greatly elongated in a tangential direction, and undergo divisions by thin radial walls. The portion figured in Fig. 45, *A* is taken from a transverse section of an adventitious root, 6 mm thick; the endodermal region lies at a depth of only 3—5 cell-layers; the Casparian dots are still recognizable here and there in the endodermis, the cells of which, as those of the primary cortex, are seen to be very greatly elongated in a tangential direction, and to have undergone secondary division. In the secondarily formed cortex the parenchyma predominates over the sieve-tissue.

In all the parenchymatous cells of the root and meso-

corme (except the outermost layer) reserve food-material was found in the form of grains, as much as 10 μ in size, round, or slightly angular, and with a small central cavity. With a solution of iodine-iodide of potassum they assumed a red-violet to brownish-red colour, which disappeared on

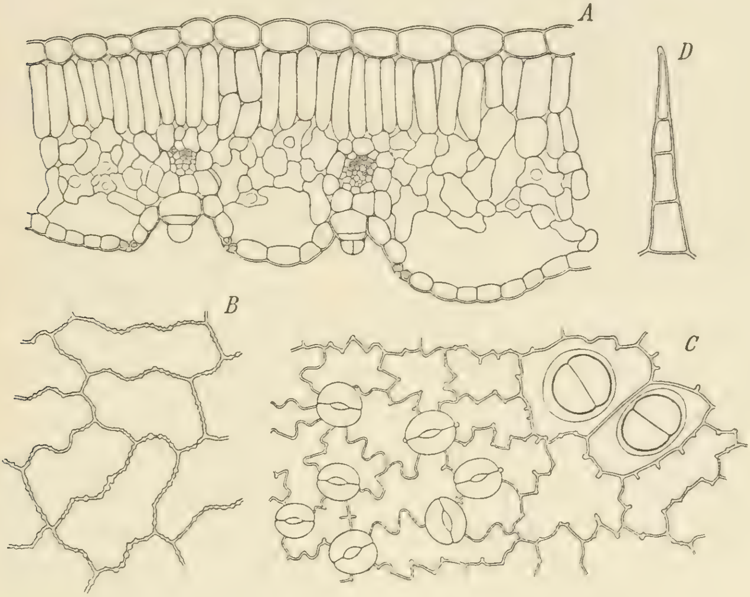


Fig. 46. *Pedicularis Oederi.*
A, Transverse section of the leaf. *B* and *C*, Epidermal cells, *B*, from the upper, and *C* from the lower surface of the leaf. *D*, A non-glandular hair. (*A* about $^{110}/_{1}$; *B* and *C* about $^{220}/_{1}$; *D* about $^{70}/_{1}$.)

heating, but reappeared after cooling; they stand out after treatment with potash-lye, and at last disintegrate altogether. Judging from the above-mentioned reactions, they must be assumed to consist of amylodextrin-starch.

The structure of the above-ground stem is fundamentally as in the other species. The thickening and lignification of the wood-fibres between and outside the vessels, and of the

peripheral cells of the pith, does not appear to take place until towards the time of ripening of the fruit.

The Leaf: Some of the cells of the upper and lower epidermis are shown in surface view in Fig. 46, *B* and *C*. Here, the great thickenings on the lateral walls of some of the epidermal cells of the upper surface and, as regards the lower surface, especially the walls of the cells which bear the glandular hairs, is very striking. This feature, however, is not constant in the species; as regards this point the individuals from Dovre were, on the whole, as shown in the figures in question, but the thickenings were far fainter, or even entirely wanting, in the specimens from Röros. As usual in the *Pedicularis* spp. the stomata occur only on the lower surface of the leaf, and the epidermal cells which surround them have highly undulating lateral walls.

A transverse section of the leaf is shown in Fig. 46, *A*. The spongy parenchyma consists of copiously-branched cells, especially in its lower layer. As seen in the figure, the epidermis of the lower surface, in the spaces between the branches of the veins, is highly convex and in places without direct connection with the spongy parenchyma, so that, on the lower surface of the leaf, there are hollow spaces — air-chambers — in the roof of which the stomata occur. In the figure, a glandular hair is seen under each of the veins; two such hairs are shown in surface view in Fig. 46, *C*. *D* is a non-glandular hair. Chlorophyll-grains occur abundantly in the whole of the mesophyll, and in the epidermis of the lower surface.

A section through one of the scars which the leaves at their fall leave on the rhizome, showed that here a cork of at least six layers was formed; outside the leaf-scars no cork-formation takes place. A small portion of such a section is shown in Fig. 45, *B*.

Summary and General Remarks.

A. Account of the Growth-form and remarks on the Structure of the Shoot, the Vegetative Reproduction and the Winter-stage.

I. Undershrub-Chamæphytes: *Veronica fruticans* and *alpina.*

The shoot-development extends over 2 years; especially in *V. alpina* the first-year portions of the shoots often assume the character of runners; this, in conjunction with the abundant development of adventitious roots, and the dying away of the older portions of the stem, makes abundant vegetative reproduction possible in this species. Special bud-scales do not occur.

Both species may form lax tufts. Nanophyllous winter-greens. In the Arctic regions they require a snow-covering during their winter-rest; *V. fruticans* requires also a habitat which is freed from snow rather early in spring.

II. Hemicryptophytes.

a. Proto-hemicryptophytes: *Castilleia pallida* and *Bartschia alpina.*

The former species has a main root of long duration; in *Bartschia* it dies away early, and adventitious roots are abundantly developed; this in conjunction with the formation of runners allows rather abundant vegetative reproduction. When *Bartschia* grows in comparatively dry and firm soil the formation of runners is checked and it forms tufts; in that case it evidently forms a transition to the undershrub-chamæphyte type. Nano-microphyllous. During the winter-rest the growing-point is protected by the scale-leaves on the portion of the shoot formed the foregoing summer. In the Arctic regions *Bartschia* (and probably also *Castilleia*) requires a snow-covering during its winter-rest.

b. Rosette- or semi-rosette plants: *Pedicularis* spp.

1. With Runners: *P. lapponica* and *P. capitata.*

In *P. lapponica* the runners are most frequently monopodial, and during a limited number of growth-periods they form few-leaved rosettes at their apex, while the floral shoots, without any preceding vegetative stage, arise laterally on the rosette-axis. Sometimes the runners may terminate their growth by the formation of a floral portion. Floral shoots may also arise laterally on the basal portion of older shoots of the same kind, so that a small *rhizoma multiceps* is developed.

In *P. capitata* the runner terminates its growth after a vegetative period of 1—3 years, by the formation of a floral portion, often without foliage-leaves (a peduncle).

The winter-buds of both species are protected by scale-leaves. Adventitious roots are developed and vegetative reproduction takes place.

In the Arctic regions *P. lapponica* (and certainly also *P. capitata*) requires a snow-covering during its winter-rest.

2. Without Runners: *P. sudetica*, *euphrasioides*, *Sceptrum carolinum*, *hirsuta*, *lanata*, *flammea* and *Oederi.*

All these species have a short vertical rhizome ("mesocorme", E. WARMING[1]); with reference to the duration of the main root, they may be divided into two groups, as stated by E. WARMING (1890, p. 206 et seq.), viz., those in which it is of long duration, a fact connected with its vigour, and often rather copious branching (*P. euphrasioides*, *hirsuta* and *lanata*), and those in which it is of short duration (*P. flammea* and *Oederi*, to which may be added *P. sudetica* and *Sceptrum carolinum*).

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[1] E. WARMING, 1918: Om Jordudlöbere (Underground Runners). With a résumé in English. Kgl. Danske Vid. Selsk. Skrifter. 8. Række. II. No. 6.

In those species in which the main root is vigorous and branched, the development of adventitious roots is repressed, and does not, at any rate, occur except in old individuals (cf. Th. Resvoll, 1917, p. 215); in the species of the other group adventitious roots are more or less abundantly developed, certainly according to the nature of the substratum. The length of the first vegetative-stage varies, as a rule, it may be of several-years duration. The variations must be assumed to be due to the varyingly favourable conditions afforded by the habitat in question, as for instance, early disappearance of snow in spring.

In *P. lanata* the winter-buds are protected by the large persistent bases of the foliage-leaves of the year's rosette; in the other species special bud-scales occur.

P. euphrasioides appears, perhaps exceptionally, to be able to occur as a biennial hapaxanth. The growth of the main shoot — in all the species which have been investigated — terminates by the development of a floral portion, frequently furnished with a few or several foliage-leaves, but sometimes quite devoid of these (individuals of *P. sudetica* and *Sceptrum carolinum*). The adventitious shoots arise most frequently in the axils of the scale-leaves; previous to their flowering they usually pass through a vegetative stage of some years duration. Only in *P. euphrasioides* the shoots usually appear to be able to achieve flowering in their second year. After fruit-setting the upper part of the shoot dies away; the complex of the persistent basal-portions forms a *rhizoma multiceps* (a mesocorme), which is especially large and vigorous when the main root is of long duration, as in *P. hirsuta* and *lanata*; these species also form the largest tufts.

In those species in which the main root and rhizome die away quickly behind, and adventitious roots are abundantly developed (especially in *P. sudetica* and *Sceptrum caro-*

linum) some vegetative reproduction takes place; but naturally by this means the plant can spread only to a very limited extent.

According to M. Porsild's observations *P. hirsuta* and *lanata* can dispense with a snow-covering during winter; all the other species of *Pedicularis* here mentioned no doubt require a snow-covering, but at the same time certainly also require that the snow in their neighbourhood shall melt rather early in spring; therefore, in the Arctic regions these species hardly belong to the real snow-trough flora, as is for instance the case with *P. hirsuta* in Norway. In southern Greenland, however, several of the species ascend rather far up the mountains (E. Warming, 1888, p. 87).

III. Therophyte: *Euphrasia arctica.*

Germinates in spring.

B. The Structure and Biology of the Flower.

In the large winter-buds of *P. sudetica*, *hirsuta*, *flammea* and *Oederi* the floral organs are found to be highly developed in the year previous to that in which they expand, and the same is probably the case in the rest of the species of *Pedicularis*. Also in *Veronica alpina* and *Bartschia alpina* floral organs have been demonstrated in the winter-buds.

The corollas are small and only slightly showy in *Veronica alpina* and *Euphrasia arctica*; in the former species the colour is deep blue, and in *Euphrasia* pale lilac to white, with yellow and violet markings. *Veronica fruticans* has bright blue corollas, which are even as much as 14 mm in diameter. *Bartschia alpina*, *Castilleia pallida* and the *Pedicularis* spp. have rather large flowers with brightly coloured corollas (deep bluish violet, red, yellow, and yellow with red or brown markings), collected into crowded and often large

inflorescences; *Bartschia* and *P. lapponica* have in addition coloured bracts.

Forms with white corollas have been found in *Veronica alpina*, *fruticans*, *P. hirsuta* and *lanata.*

Honey-secretion, either by a secretory ring around the ovary (*Veronica*) or by protuberances at its base, has been demonstrated in the majority of the species. Perfume is present in *P. lapponica*, *sudetica*, *euphrasioides* and *lanata.* The species which have been investigated varied from homogamous to slightly protogynous.

In *Veronica alpina* and *Euphrasia arctica* self-pollination is no doubt customary.

In the Arctic regions self-pollination no doubt plays an important part as regards the *Pedicularis* spp. since, according to several investigators (Ekstam, Porsild, etc.), insect-visitors are very scarce or even totally wanting there, and in Spitzbergen, as mentioned by Aurivillius, and as has since often been pointed out by others, none of the natural pollinators of these flowers (humble-bees) are found; in spite of this absence, *P. hirsuta* and *lanata* regularly set fruit there.

When, as in *P. flammea*, the stigma is always included in the helmet on account of the shortness of the style, cross-pollination by insects seems to be impossible. In *P. hirsuta* (no doubt frequently) and *lanata* (sometimes) the upper part of the style can be found to be so strongly curved that the stigma is pressed against the under-side of the anthers; perhaps this is due to movement which has taken place during a later stage in the flowering, so that originally cross-pollination has been possible; in the majority of the flowers of *P. lanata* which have been investigated, the stigma was found to protrude slightly beyond the tip of the helmet, as also in *P. sudetica.* In these three species the flowers are set almost horizontally, and the stigma is therefore placed under

the anthers, so that at any rate the dry and light pollen, when it falls out of the anthers by accidental shaking of the plant, will easily be able to fall upon the almost globular stigma. Self-pollination must take place with somewhat more difficulty in *P. euphrasioides* and *lapponica* owing to the great obliquity of the flower. The latter species, which has in addition the most protrusive stigma, is no doubt also the worst self-pollinator, and according to Porsild it is also the poorest fruit-setting species in Greenland.

In *P. Oederi*, in which the flower, as in *P. flammea*, stands almost in a vertical position, the upper lip curves forward and downward at the end of the flowering period, by which means the stigma is brought in a position that enables it to receive the pollen when it falls.

Pedicularis Sceptrum carolinum, as *Castilleia pallida*, no doubt normally requires insect-visits for pollination. *Bartschia alpina* is characterized by great variation in the length of its style; in the short-styled forms, especially in those in which the stigma is included in the helmet, self-pollination must easily be able to take place; any appreciable growth of the corolla tube has not been demonstrated in the Arctic regions, so the variations must be regarded as individual. On the other hand, in several instances of older flowers, the anthers were found to project outside the corolla so that in these cases we may perhaps assume with Kerner that some amount of cross-pollination takes place between older and younger flowers by the agency of the wind.

With the exception of *P. capitata* I found, in my material, ripe fruit in connection with all the species.

The seeds were small and light in all the species.

C. Parasitism.

As is well-known the *Euphrasia* spp., *Bartschia alpina* and the *Pedicularis* spp. are green semiparasites.

As regards their capability of assimilating the carbon dioxide of the air, Heinricher (1910, VI, p. 574) states that in the *Euphrasia* spp. this is almost normal, and the same author also attributes active assimilation to *Bartschia*. Volkart (1899, p. 30) sums up his results as regards the *Pedicularis* spp. (*P. recutita*, *foliosa* and *verticillata*) investigated by him as follows: "Die Versuche zeigen, dass die Stärkespeicherung der Blätter der untersuchten Pedicularisarten normal und ohne grosse Abweichung von denjenigen anderer Pflanzen vor sich geht. Eine weitgehende Herabsetzung der Assimilationstätigkeit durch den Parasitismus, wie sie Bonnier aus seinen Versuchen ableitet, findet nicht statt."

In this connection I wish to draw attention to the fact that the mesophyll, in all the *Rhinantheæ* spp. investigated by me, was found to be normal in structure, and its cells contained a normal supply of chlorophyll grains.

Bartschia alpina according to Heinricher's investigations, is an obligate parasite. According to Volkart, the *Pedicularis* spp. may show gradations in their dependency on other plants; from *P. palustris*, which he describes as "Stärkster Parasit mit stark entwickelter Neigung zur saprophytischer Ausnützung der Nährpflanze" (by the destruction of the roots attached), to *P. comosa*, which is said to be a "Relativ selbeständig entwichlungsfähige Art"; as regards *P. Oederi* he writes "Saprophytische und hydroparasitische Ausnutzung der Nährwurzel gleichgestellt."

From the Arctic regions we lack accounts of thorough investigations regarding this matter; but as regards *P. lanata* there is a note to hand which might suggest that under

certain circumstances this species may at times lead an independent life, since M. Porsild remarks (1920, p. 142) that he has found *P. lanata* growing "in gravelly barren, far away from other plants"; where it occurs among other plants, this species, also, has haustoria on its roots (l. c.).

According to Volkart, in the Alps the *Pedicularis* spp. do not appear to be very particular as regards host-plants. From the Arctic regions Rosenvinge and Warming records *P. hirsuta* and *flammea* as parasitic on *Vaccinium uliginosum* and *Salix herbacea*; Hartz (1905, p. 219) writes that in East Greenland *P. lapponica* "is closely connected with *Betula*, and probably occurs parasitically on its roots." A rather interesting circumstance connected with the present question is recorded by Chr. Kruuse (1911, p. 61) from the district of Angmagsalik. On some slopes facing north and cut into terraces, where a rich vegetation of "espalier-shrubs" was growing on the vertical sides of the terraces, he found the platforms to be "covered with coarse gravel which bore at great intervals (3—5 metres) wind-affected tufts of *Salix* (*Salix glauca*)", and in these tufts a *Pedicularis* (*hirsuta* or *flammea*) always occurred. "Where the platforms consist of sand, *Salix herbacea* is always predominant, and the latter also, with its crooked branches 5—10 cm long, protects a *Pedicularis*."

D. Anatomy.

The Root. Both the species of *Veronica* have a thin-walled, cuticularised exodermis; *V. fruticans* has a peripheral cork-formation in the root (as in the stem), whilst this is lacking in *V. alpina*. In both species the primary cortex persists a long time and, especially in *V. fruticans*, consists of rather thick-walied cells; the original endodermal cells are elongated during growth and undergo divisions by radial

walls which are quite thin in *V. alpina*, but of the same thickness as in the other cells of the cortex in *V. fruticans*. In the latter species there are distinct growth-zones in the xylem-portions of the stele, whilst such growth-zones are lacking in *V. alpina*.

It is common to the roots of *Euphrasia*, *Bartschia* and the *Pedicularis* spp. to have the primary cortex few-layered and its cells frequently very thin-walled; root-hairs are usually wanting (in some specimens of *Euphrasia arctica*, alone, I found a few scattered root-hairs).

In the species of *Euphrasia* the epidermis persists a long time; according to HOVELACQUE the same is the case in *Bartschia*, but in this I found that it may sometimes die away early. With the exception of *P. Sceptrum carolinum* it dies away very quickly in the *Pedicularis* spp. which have been investigated; even in roots a millimetre thick, I found the cells collapsed and partly thrust off; the outer walls of the layer below the epidermis become cuticularised, and where the growth in thickness of the root is considerable (*P. euphrasioides*, *hirsuta*, *lanata*, *flammea* and *Oederi*) the cells of the exodermis as well as of the other 3—6 layers of the primary cortex become greatly elongated tangentially and divided by thin radial walls.

The primary cortex persists a long time.

In *Bartschia alpina* and *P. capitata* a cuticularised lamella arises in the wall of the endodermal cells, in the former species all the way round, in the latter only in the inner and radial walls.

The Casparian dots were very distinctly discernable in *Euphrasia arctica*, and in *P. lapponica*, whilst they were quite faint in *P. hirsuta* and *lanata*.

Lacunæ, such as are found, for instance, in the primary cortex in *P. palustris* (HOVELACQUE), were, in the species

investigated, found well-developed in the adventitious roots of *P. sudetica* only.

In the roots of *P. Euphrasioides*, *hirsuta* and *lanata*, which had a vigorous growth in thickness, the rather thick secondary cortex was found to be traversed by radiating clefts (Fig. 38, *B*); this was less well-marked in the adventitious roots of *P. flammea* and *Oederi*. In *P. hirsuta* and *lanata* in which the thin-walled parenchyma — as is also the case in *P. flammea* and *Oederi* — is also dominant in the xylem, the clefts are often continued far into the latter.

In the xylem of *P. euphrasioides* distinct growth-zones were seen, each probably corresponding to one year's increment.

The thick roots and rhizomes in several of the *Pedicularis* spp. certainly contain a considerable amount of reserve food material, no doubt especially during the winter-rest; the sweet taste of these organs in *P. hirsuta* and *lanata* is well-known. In *P. flammea*, *Oederi* and in the specimen of *P. hirsuta* mentioned on page 462, which was collected in late summer, I found the roots full of amylodextrin-starch.

The condition of the material at my disposal did not allow of a closer study of the haustoria.

The Stem. As has frequently been pointed out (HOVELACQUE and SOLEREDER) the absence of parenchyma-rays from the part of the xylem formed by the cambium, is a character widely distributed among the Scrophulariaceæ.

Parenchyma-rays were also absent from all parts of the shoot in the *Veronica* spp., *Castilleia pallida*, *Euphrasia* and *Bartschia alpina*, and from the above-ground parts of the axes in the *Pedicularis* spp. (in *P. lapponica* also from the runners). In these cases the cambium very quickly develops inwardly a continuous ring of vessels and wood-fibres, which bridges over the leaf-gaps so that these become demonstrable

on the inner side of the xylem-ring only as thinner portions of the latter among "les faisceaux reparateurs".

A transverse section of the rhizome in *P. sudetica*, *Sceptrum carolinum*, *hirsuta*, *lanata*, *flammea* and *Oederi* showed, on the other hand, a circle of vascular bundles mutually separated by parenchyma-rays, as is commonly the case in fleshy dicotyledonous rhizomes, especially such as are abundantly covered with leaves. With respect to *P. Sceptrum carolinum* this feature has been already described and figured by Chatin.[1] In *P. capitata* the runners had two rather broad diametrically opposite parenchyma-rays.

In the above-ground parts of the axes in the *Pedicularis* spp. the peripheral portions of the pith consisted usually of thickened, lignified and porose cells; this was most decidedly the case in *P. Sceptrum carolinum*, in the up to one-metre-high stem of which the stereom is, on the whole, very vigorously developed. When an elongation of the axis takes place during flowering and fruitsetting, the lignification of the stereom naturally does not begin until this is accomplished. The central portions of the pith are very thin-walled and die away early.

Hard bast was present in the periphery of the stele in *Veronica fruticans*, and very abundantly in the above-ground parts of the axis in *Bartschia alpina*; in the rhizome of the latter species the hard bast was present more sparingly, and sometimes totally absent.

Continued growth in thickness through several growth-periods could be observed in the persistent basal portions of the shoots of the two Arctic species of *Veronica* (in *V. fruticans* the growth in thickness is continued throughout many years — as many as 16 were counted), in *Castilleia*

[1] Chatin: Anatomie comparée des vegetaux. Plantes parasites. Dicotylédones. P. 192. Pl. XLII.

pallida (the increment was small and irregular) and sometimes in *Bartschia*; the runner-like portions of the shoots in *P. lapponica* occasionally show two annual rings; in the rhizomes in *P. Sceptrum carolinum* the xylem of the vascular bundles always showed two growth-layers, since in the second year of the rhizome-portion a group of vessels (and stereom) is developed outside that produced in the first year; the two groups are distinctly separated, some layers of thin-walled unlignified parenchyma being found between them. Thin-walled and unlignified cells are also present in the *Veronica* spp. at the boundary between the annual rings.

Cork-development occurs sub-epidermally in *Veronica fruticans* in the basal, persistent portions of the shoots, and in *P. Sceptrum* and *capitata* further within the primary cortex; the cork is always only few-layered, but *P. Sceptrum carolinum* develops, in addition, cork-cambiums in the parenchyma between the annual increments in the vascular bundles and also within the pith. In the majority of cases the endodermis was demonstrable by the presence of Casparian dots, or else a cuticularised lamella was found in its walls, either all the way round (as in the runners in *Bartschia*) or only on the inner and radial walls (runners of *P. capitata*).

The Leaf. All the species investigated have leaves mesomorphic in structure. The cuticle is thin; in *Veronica fruticans* a moderate thickening of the walls of the epidermal cells takes place, the other species have thin walls. The lateral walls of the epidermal cells of *Castilleia pallida* are almost straight, of the other species more or less decidedly undulating; in *Euphrasia arctica* and *Bartschia alpina* the difference between the epidermis of the upper and lower surfaces is in this respect inconsiderable; in the species of *Veronica* and *Pedicularis* I found that the epidermal cells of

the lower surface had the most decidedly undulating lateral walls.

The lateral walls of the epidermis in *Veronica alpina*, *Castilleia pallida* and *Euphrasia arctica* are without sculpture; in the other species they are porose; in *Veronica fruticans* and *Pedicularis euphrasioides*, *flammea* and *Oederi* the pores are distinct and alternate with flanged thickenings, whereas they are fine in *Bartschia alpina* and the other *Pedicularis* spp. It should be noted, however, that the epidermal cells of the lower surface which bear the large glandular hairs have (except in *P. lanata*) very vigorously developed flanged thickenings in the *Pedicularis* spp., and usually also in *Euphrasia* and *Bartschia*; also their walls are, on the whole, distinctly thicker than those of the surrounding epidermal cells.

Stomata occur exclusively on the lower surface of the leaf in the *Pedicularis* spp., nearly equally on both surfaces in *Veronica fruticans*, *V. alpina*, *Castilleia pallida* and *Euphrasia arctica*, and more abundantly on the lower surface in *Veronica officinalis* and *Bartschia alpina*. The guard-cells are on a level with, or raised only slightly above the leaf-surface; they are surrounded by 3—8 cells.

The mesophyll in all cases is rather lacunose and consists of thin-walled cells. In *Castilleia pallida* it may be almost homogeneous; 2—3 layers of short palisade-cells occur in the *Veronica* spp., *Euphrasia arctica* and *Bartschia alpina*. Of the *Pedicularis* spp., *P. euphrasioides*, *capitata*, *hirsuta*, *flammea*, *Oederi*, and frequently *lapponica*, had 1—2 layers of typically developed palisade-cells; they were shorter and broader in *P. Sceptrum carolinum*, *sudetica* and *lanata*.

In *P. flammea* and *Oederi* there were large air-chambers between the spongy parenchyma and the epidermis of the lower surface (cf. Fig. 46, *A*). In all the species investigated,

the cells of the mesophyll contained a normal number of chlorophyll-grains. In the majority of the cases chlorophyll-grains were also present in the epidermis of the lower surface.

Only *P. lapponica*, *Sceptrum carolinum* and *flammea* appear to be totally devoid of non-glandular hairs. The leaves were densely covered with hairs in *Castilleia pallida*, *Euphrasia arctica*, *Bartschia alpina*, *P. hirsuta*, *lanata* (in the last-mentioned two species especially along the edges of the petiole on the part near the base of the leaf) and *capitata* (on the lower leaf-surface and the petiole). The non-glandular hairs are from one to several-celled; in *Veronica fruticans* and *Pedicularis capitata* they are rather thick-walled, in the others thin-walled, smooth or with fine cuticular striations; only *Veronica fruticans* had hairs with coarser cuticular warts.

Glandular hairs were present in all the species: small glandular hairs with a one-celled stalk and two-celled head in the *Veronica* spp., *Castilleia pallida* and in especially great numbers in *Euphrasia* and *Bartschia alpina*; the last-mentioned two species had in addition large, peltate glands with a low sunk stalk-cell and a 2—4 celled flat head, like those in *Lathræa* (Scherffel, Haberlandt and Goebel; compare my Figs. 14 and 19). As previously mentioned by Hovelacque and Percy Groom, large glandular hairs of peculiar structure occur also in the *Pedicularis* spp.; here the low stalk-cell is not sunk, and the head is 2-celled (see for instance Fig. 23, *A* and *C*). All the species of *Pedicularis* which have been investigated had such glands.

The above-mentioned special forms of large glands are found only on the lower surface of the leaf and, as pointed out by the above-mentioned authors and as may be seen from my figure 24 and from most of the transverse sections of leaves figured, they are localised under the vein-branches

of higher order which at their tips consist only of a few thin-walled tracheids. According to information to hand it seems unquestionable that these glands are organs for the secretion of water.

As to the *Pedicularis*-glands it should be noted that special water-paths from the tracheids to the basal cell of the glandular hair, limited by the cuticularisation of cell-walls, as have been demonstrated in *P. palustris* by Percy Groom, have not been able to be demonstrated in any of the species investigated here. A bursting and crumbling-away of the cuticle on a small circular spot in the middle of the glandular head, such as the author in question mentions in connection with *P. palustris*, was very common in *P. lapponica* and *P. Sceptrum carolinum*, and was occasionally also found in other species.

Glandular hairs with a 2 to several-celled stalk and a 2—4 celled head were present in *Castilleia pallida*, *Euphrasia arctica*, *Bartschia alpina*, and also in *P. flammea*.

TYP. BIANCO LUNO. KBHVN.

4.

THE BRYOPHYTA OF ICELAND

BY

AUG. HESSELBO

WITH 39 FIGURES IN THE TEXT

INTRODUCTION.

Previous to the time when Grönlund made botanical collections in Iceland (1868 and 1876) the Bryophyta of the island was very little known. Earlier botanists, who occasionally collected specimens also of the Bryophyte Vegetation, have only exceptionally given information as regards localities, and the older lists consist merely of an enumeration of species without any information as regards distribution or frequency. To this must be added that the older determinations of species are very uncertain, and in many cases undoubtedly erroneous or quite improbable, and that the lists are compiled quite uncritically without stating the name of the collector or the source of the information. For instance, more than half of the 149 mosses and 54 hepatics enumerated in Lindsay's list are undoubtedly wrongly determined, and the majority of them beyond doubt do not occur in Iceland. Therefore, in preparing the following list of the Bryophyta of Iceland, older records have been taken into consideration only when it has been possible to verify them by means of specimens in the collections.

The material dating from older collections (previous to Grönlund's) is but very scanty. Mörch was the first to contribute anything of importance to our knowledge of the Bryophyta of Iceland. In 1820 he collected a rather considerable number of species, among which are many that were not found again until quite recently, and even several which have not since been found by others. Mörch's collections are in the Botanical Museum in Copenhagen, but unfortunately he has in only quite a few cases recorded the habitat on the wrappers. W. J. Hooker (1809), Lindsay (1860) and Caroll (1861) collected mosses and hepatics in Iceland, but as mentioned above, Lindsay's list, in which

these finds are enumerated, is so full of mistakes that it is quite worthless.

Japetus Steenstrup collected (1839–49) some Bryophyte samples in West and North Iceland and in the interior of the country.

But it was not until Grönlund's investigations that the foundation was laid of a real knowledge of the Bryophyte Vegetation of Iceland, he not only critically revised the older lists, but also prepared lists of his own collections. It was also Grönlund who was the first to give real descriptions of moss societies. Grönlund's journeys in 1868 and 1876 extended over West and North Iceland, from Reykjavik across Esja to Borgarfjördur and thence to Skagafjördur, Eyjafjördur and Mývatn. He did not visit East, South and North-west Iceland.

In recent times the Iceland botanists Ólafur Davidsson, Stefán Stefánsson and Helgi Jónsson have contributed considerably to our knowledge of the Bryophyta of Iceland.

Ólafur Davidsson (died 1902) made, during 1899—1900, very considerable and valuable collections in North Iceland around Eyjafjördur and Skagafjördur and on the small island of Grimsey north of the Arctic Circle. His collections, which belong to the Reykjavik Museum, have only now been determined.

Stefán Stefánsson, the head of a school in Mödruvellir and member of the Althing up to 1916, has made collections during many years, especially in North and North-east Iceland. The greater part of his material is published in Grönlund's list.

Helgi Jónsson, Dr. phil. and teacher in Reykjavik, on his numerous journeys to almost all the different parts of the island, has everywhere collected specimens of the Bryophyte Vegetation, and in his descriptions of the vegetation of Iceland has usually mentioned the Bryophyta also. His collections, which are preserved in the Botanical Museum in Copenhagen, are determined by C. Jensen. Besides the botanists mentioned above, a few others have also occasionally collected specimens of the Bryophyte Vegetation. C. Ostenfeld, during a few short visits, has especially investigated the lava-fields and the hot springs near Reykjavik and on the peninsula of Reykjanes. A. Feddersen (1884—86) made some collections in South and West Iceland. Dr. C. Hansen, Professor Th. Thoroddson and Pétur Sophoniasson collected mosses

in several places. The majority of these collections are determined by C. Jensen and included in Grönlund's list (1895).

My own investigations were made on three journeys, viz. in 1909 and 1912 by the aid of the Carlsberg Fund, and in 1914 by the aid of the Botanical Travelling Fund, and Japetus Steenstrup's Legacy. In 1909 I investigated in the beginning of June the region around Reykjavik and Hafnarfjördur, and made a five day's trip to the Esja mountains. On June 9th I sailed to Hornafjördur in South-east Iceland, and after staying a few days there went straight through East Iceland to Seydisfjördur, where I arrived on June 30th. On the way I stopped at several farms, viz. Stafafell, Hof, Djupivogur, Berufjördur, Höskulstadr and Vallanes. On July 9th I took the coast steamer to Husavik in North Iceland, and after some days sojourn there went into the interior of the island across Ás and Svinadal to Reykjahlid near Mývatn, and after having stayed a few days there to Akureyri. Unfortunately investigation in this interesting region was almost entirely prevented by continual rain and fog. I stayed five days in Akureyri and then continued my journey westwards through North Iceland to Stadur near Hrutafjördur, stopping at the farms Tverá in Øxnadalur, Vidimyri, Vidivellir, Geitaskard, Hnausar and Lækjarmot. From Stadur I rode across Haukadalsheidi and Brattabrekki to the farm Dalsmýnni in Nordredalur, where I arrived on August 2nd. After staying a few days there in continual rain, I was obliged to abandon my original plan of travelling by land to Reykjavik and, instead, to ride to Borgarnes and take the steamer to Reykjavik.

In 1912 I arrived at Reykjavik on June 2nd and rode thence past Kolvidarhol to Reykir, where the vegetation around the hot springs was investigated, and thence to Skálholt, Laugardalur and Thingvellir, staying a few days at each place, and then back again to Reykjavik, whence I sailed on June 15th to Dýrafjördur in North-west Iceland. On the way I had an opportunity during a 24 hours stay in Stykkisholmur to investigate the immediate neighbourhood. After a three days stay at Dýrafjördur I rode on June 20th to Isafjördur, whence, during the following three weeks, I made numerous excursions, partly, on foot, to the surrounding country and to Sugandafjördur, and partly to the north-west side of the fjord and the district around Jökulsfjördur, to Hesteyri and the whole tract of land from the head of Jökulsfjördur to Stadur, and from Bæir to Arngerdareyri.

On July 10th I returned to Reykjavik by the steamer "Botnia", and rode thence through Esja and around Hvalfjördur to Reykholtdalur, where I stayed some days and investigated the hot springs, and made an excursion to the farm Gilsbakki. On my way back I passed through Reykholtdalur and Lundurreykjadalur to Thingvellir, and thence to Reykjavik.

On my last journey in 1914 I stayed on the island of Vestmannaey, which I had previously had opportunity to visit only for a few hours, on my way to Reykjavik, from the 4th to 9th July. I went to Reykjavik on the 10th, and rode on the same day to Kolvidarhol, and thence further across Reykir and Thjorsártun to Fljotshlid near the Markarfljot, where I stayed some days at the farms Breidabolstadr and Barkarstadr. On the 17th I rode across the great river Markarfljot to the vicarage of Holt, south of Eyjafjallajökull, and stayed partly there and partly at the farms Drángshlid and Seljaland until July 24th, when I recrossed the Markarfljot on horseback, and rode past the farms Thjorsártun and Skálholt to Geysir, and thence across Thingvellir to Reykjavik, where my journey ended abruptly on August 1st on account of the outbreak of war.

As may be seen from the above survey, Iceland is as yet very incompletely investigated as regards bryology. All previous collectors, with the exception of Grönlund, had no, or almost no, knowledge of the Bryophyta, and have, therefore, only been able to take chance specimens, which must, therefore, often give a misleading idea of the composition of the vegetation. The great distances, together with a slow and toilsome journey on horseback, render investigation difficult, and rain and fog often greatly delay the work, and make it almost impossible to travel in the mountains.

The most thoroughly investigated regions are South-west Iceland from Eyjafjallajökull to Borgarfjördur, East Iceland from Hornafjördur to Seydisfjördur, the districts around Eyjafjördur in the north and around Isafjardardjup in the north-west. Throughout large parts of the country mosses have, practically, never been collected: thus, in the north-east from Seydisfjördur to Axarfjördur, in South Iceland from Vik to Hornafjördur, in the greater part of North Iceland and in almost the whole of the large interior plateau. Therefore this list of the Bryophyta found in Iceland can by no

means be regarded as complete, and future investigations will undoubtedly effect great alterations in our present knowledge of the distribution of the species in the different parts of the country.

ABBREVIATIONS OF NAMES.

O. D. = Olafur Davidsson
F. = Feddersen.
Grl. = Grönlund.
Ho. = Hornemann.
H. J. = Helgi Jónsson.
C. J. = C. Jensen.
Ostf. = C. H. Ostenfeld.
St. = Stefán Stefánsson.
Stp. = Japetus Steenstrup.
! or (!) = A. Hesselbo.
()! = The specimen seen by A. Hesselbo.
M. B. H. = The Botanical Museum of Copenhagen.

I. LIST OF THE BRYOPHYTA.

I. HEPATICÆ.

Fam. RICCIACEÆ.

1. **Riccia bifurca** Hoffm.

N. Iceland: Hrossaberg (St.)!; Vidimyri (Grl.)!; Mývatn!. S. Iceland: Near Reykjanes lighthouse (Ostf.)!; Kverkfjall (Wegener.)!.

In all these localities it grows on warm, damp clayey flats near hot springs. Near Mývatn — where it grew abundantly around fumaroles, from which issued aqueous vapours containing sulphuretted hydrogen — the temperature of the soil was about 40°[1] about one cm. below the surface. Near Reykjanes lighthouse Ostenfeld (Bot. Tidsskrift, vol. XXII, 1899, p. 239) gives the temperature of the soil as 20°—30°. All the plants investigated bore capsules.

2. **Riccia sorocarpa** Bischoff.

N. Iceland: Reykjalaug in Fnjoskadal (O. D.)!. S. Iceland: Grafarbakki near the Minni Laxá (F.)!; Laugaráshver!.

Like the preceding species, *R. sorocarpa* grows on warm, damp clayey flats. Near Laugaráshver it was found abundantly on clayey slopes stretching down towards the boiling hot spring. There the temperature of the soil was about 25°—30°. All the plants investigated bore capsules which in the plants from Laugaráshver were fully ripe at the end of July.

3. **Riccia crystallina** L.

S. Iceland: Thorlakshver near Skálholt!. (27. 7. 1914).

The plants, which had fully developed capsules, grew widely scattered on clayey flats, otherwise bare of vegetation, around some small holes from whence issued boiling water accompanied by vapours slightly impregnated with sulphuretted hydrogen.

Note. *Riccia glauca* L. is mentioned by Zoëga and is recorded by Hornemann as occurring abundantly near Geysir. But as no specimens of it are to be found in the collections, and during the search made in 1914, no species of *Riccia* were found near Geysir, it is impossible to determine what species is meant.

[1] Here and throughout the book the centigrade scale is meant.

Fam. MARCHANTIACEÆ.

4. **Sauteria alpina** Nees.

N. Iceland: Grænuhnukr in Brattafjallgardi between Mödruvellir and Brú (St.).

5. **Reboulia hemisphærica** (L.) Raddi.

SW. Iceland: Hafnarfjördur (H. J.)!. S. Iceland: Drángshlid (H. J.)!; Holt!; near Skógafos!; Seljaland!.

This plant was found only in the southern part of the country, but it appears to occur there rather frequently. Near Hafnarfjördur it was found in a lava cave; in S. Iceland it was collected everywhere from the somewhat damp faces of tuff rocks, especially from the base of the sides of illuminated caves in tuff cliffs; in this situation it usually grew in company with *Preissia commutata*, *Fegatella*, *Marchantia*, *Anoectangium compactum*, *Distichium montanum*, etc. It was found everywhere in fruit which was almost ripe at the end of July.

6. **Fimbriaria pilosa** (Wahlb.) Taylor.

N. Iceland: Hof (O. D.)!; Boggverstadadalur (O. D.)!. NW. Iceland: Bæir on Snæfellsstrand!.

Near Bæir it grew abundantly on a stony slope facing south and stretching down towards the sea, upon rather dry, humus-covered rocks. It was everywhere collected in fruit which near Bæir had just ripened on June 6, 1912.

7. **Fegatella conica** Corda.

Hepatica conica Lindb.

S. Iceland: Drángshlid (H. J.)!; Merkjáfoss (F.)!; Breidabolstadr!; Barkastadr!; Seljaland!; Holt!; Drángshlid!; Skógafos!.

This plant was not found except in S. Iceland, but there it was common in all the parts which were investigated. It grew there everywhere on faces of tuff rocks, especially on those of caves and clefts, and more particularly on the faces with a southern exposure where it may occur very abundantly, sometimes on the damp tuff rocks themselves and sometimes creeping over mosses, for instance *Hypnum filicinum*, *Eurynchium Swartzii*, etc. Sterile specimens only have been found.

8. **Preissia commutata** (L.) Nees.

Chomocarpon quadratus (Scop.) Lindb.

N. Iceland: Hof, fr. (O. D.)!; Mödruvellir (O. D.)!; Hrossaberg on warm clayey flats, fr. (St.)!; Stora Gjá near Mývatn!. NW. Iceland: Stadr on Snæfellsstrand, fr. (Stp.)!. W. Iceland: common near the hot springs in Reykholtdalur!; Hafnarfjördur!. S. Iceland: Thingvellir (Grl.)!

Laugardal Grl.:!); Reykjanes near hot springs (Ostf.)!; common everywhere on faces of tuff rocks in Fljotshlid and below Eyjafjallajökull!.

Preissia commutata occurs both on more or less damp ground and on damp rocks, and also on warm clayey flats near hot springs. In the last situation, as in Reykholtdalur, it covers large areas on slopes stretching down towards the boiling hot water. In E. Iceland it has not yet been found; in N. and NW. Iceland it is rather rare and grows there on damp rocks, along river-banks or in rock-clefts. In S. and SW. Iceland it is frequent in lava-clefts near Thingvellir and Hafnarfjördur, and in S. Iceland proper it is very common. There it grows at the base of, or some way up the rock faces, especially upon those with a southern exposure, or in sheltered clefts, and often occurs in great abundance, and fruiting richly. The fruit was not quite ripe even at the end of July.

9. **Marchantia polymorpha** L.

Common all over Iceland on damp soil, on rocks, by rivers, in marshes and in moss bogs, and very often found with fruit or antheridiophores. It is extremely common especially in NW. Iceland, and covers banks of streams often in great abundance, to a height of about 300 metres. In S. Iceland it is also very common on damp tuff rocks.

This species is most widely distributed in the birch zone to a height of about 300—400 metres above sea-level where it usually grows on marshy or gravelly ground along small streams, or occurs in abundance in moss bogs or in marshes among mosses. But it is also met with upon mountain heights, as for instance near Berufjördur, Seydisfjördur and Isafjördur, where it has been collected abundantly up to a height of 600—700 metres.

Fam. ANEUREÆ.

10. **Aneura pinguis** (L.) Dum.

Riccardia pinguis (L.) Gr.

Very common on damp ground both in marshes and on gravelly soil by rivers and also on damp rocks. It usually grows intermixed in the tufts of other Bryophyta, rarely forming tufts by itself; it has been collected in fruit in a few localities only near Eyjafjördur, and near Seljaland at an altitude of about 500 metres. It is most widely distributed in the lowlands up to about 300 metres, but it is also frequently met with upon mountain heights.

11. **Aneura multifida** (Lindb.) Dum.

Riccardia multifida (Lindb.) Lindb.

E. Iceland: Lon!, on swampy ground among *Sphagnum rubellum*; W. Iceland: Reykholtdal!, frequent near hot springs intermixed in the

tufts of other Bryophyta such as *Sphagnum rubellum*, *Scapania irrigua*, and *Pellia Neesiana*. In one place it was growing on a stone which protruded slightly above hot water of a temperature of about 50°; there it was growing intermixed in a tuft of *Enthostodon ericetorum*, *Scapania irrigua* and *Anthoceros punctatus*.

This species is recorded by Mörch from Iceland, but no specimens of it are to be found in the collections.

12. **Aneura latifrons** Lindb.

Riccardia latifrons (Lindb.)

N. Iceland: several places near Eyjafjördur (O. D.!; Akureyri!; Husavik!. NW. Iceland: Laugarland!. SW. Iceland: Reykjavik!; Kollafjördur!.

This plant usually grows on peaty soil intermixed in the tufts of other Bryophyta such as *Dicranella crispa*, *Lophozia Kunzeana*, *Sphagnum* spp. and *Aneura pingvis*. Near Husavik it was growing among *Leptobryum pyriforme* on damp gravelly ground.

Fam. METZGERIEÆ.

13. **Metzgeria furcata** (L.) Lindb.

Commonly distributed all over Iceland in dry rock-clefts and on rock-faces, usually associated with *Radula complanata*. In S. Iceland, where it is very common on rock-sides in clefts of tuff rocks, it is sometimes found also in rather damp localities. Only sterile specimens have been found.

Metzgeria furcata is a typical lowland-plant. In Iceland it has not been found at a higher altitude than about 300 metres.

Fam. HAPLOLÆNEÆ.

14. **Pellia Neesiana** (Gottsche) Limpr.

Marsilia Neesiana Lindb.

Very common on wet ground especially along river-banks, in moss bogs and on inundated ground; somewhat more rare in marshes. It grows almost always intermixed in the tufts of other Bryophyta, and usually as an erect, elongated form among *Philonotis*, *Mnium cinclidioides*, *Acrocladium cuspidatum*, *Marchantia*, etc., more rarely it grows in unmixed tufts on damp ground. Fruit appears to be produced rather rarely and also rather sparingly.

This species has its main distribution in the lowlands up to about 300—400 metres, and it is only by exception that it has been found above this level.

Pellia epiphylla (L.) Lindb. is enumerated in the majority of the

older lists, and Grönlunds records it from many localities in Iceland, but all the specimens found in the collections under this name are those of *Pellia Neesiana.*

15. **Blasia pusilla** L.

N. Iceland: Reykum (Grl.)!; Melar (Grl.)!; several places near Mödruvellir near Eyjafjördur (O. D.)!; Reykjalaug in Fnjoskadalur (O. D.)!; Öxnadalur!; Stadr near Hrutafjördur!. W. Iceland: Gilsbakki!; common in Reykholtdalur!. S. Iceland: Reykirdalur!.

Only the ♂ plant has been found in Iceland.

This species occurs in rock-clefts and along the banks of streams, on wet gravelly ground, and also on clay near hot springs. For instance, it grows abundantly in Reykholtdalur, and more scantily in Reykirdalur on the damp, steaming clayey flats, the temperature of which just below the surface is about 25°—40°; it is found associated with *Gymnocolea inflata, Haplozia crenulata* and *Fossombronia Dumortieri.*

On banks of streams it usually grows rather scantily and associated with *Dicranella crispa, Pellia Neesiana, Didymodon rubellus, Angströmia longipes, Scapania subalpina,* etc.

Note. *Mörchia Blyttii* (Mörch) Brockm. is recorded by Grönlund to occur in Brynjudalur, but the specimens preserved in the Botanical Museum in Copenhagen belong to *Blasia pusilla.*

Fam. CODONIEÆ.

16. **Fossombronia Dumortieri** (Hüb. et Genth) Lindb.

N. Iceland: near Mývatn!. S. Iceland: near hot springs on Reykjanes (Ostf.!); Reykir!; Thorlákshver!; Laugaráshver!; Sydri Reykjahver!; Thingvellir!; Kolvidarhól!; Geysir (Ho.:!). W. Iceland: common near hot springs in Reykholtdalur!.

Fossombronia Dumortieri is one of those species which are rarely absent from the neighbourhood of any hot springs if only the water does not contain too much sulphuretted hydrogen. There it grows on warm clayey flats with a temperature of about 40°, and especially on damp slopes along the outlets of springs; as a rule it sets fruit which ripens during June—July.

In Reykholtdalur it is common near all the hot springs, also near the springs on Riskupstungur, near Geysir and on Reykjanes. In Reykirdalur, where the majority of the springs give out abundance of sulphuretted hydrogen in their vapours it occurred less frequently, but nevertheless was found near several springs, also around some small fumaroles near Kolvidarhol from which issued aqueous vapours impregnated with sulphuretted hydrogen. It grows in all these localities associated with other Hepaticæ, for instance *Gymnocolea inflata, Haplozia crenulata* and *Anthoceros punctatus.* Near Mývatn it was growing around a fumarole, on a damp clayey flat with a temperature of about 40°, associated with *Riccia bifurca* and *Haplozia crenulata.* The only place

where the plant has been found on other than warm ground is near Thingvellir where it was growing in a ditch along the road to Hrafnagjá, on clay washed together into a heap; there it had for companions *Dicranella crispa*, *Didymodon rubellus*, *Eucalyx subellipticus* and tiny plants of *Pohlia*, *Bryum*, etc.

Fam. EPIGONANTHEÆ.

17. **Gymnomitrium corallioides** Nees.

S. Iceland: Thingvellir (Stp.; Grl.;!); Seljaland (Stp.;!). SW. Iceland: Reykjavik (Grl.;!); frequent in Esja!; Hafnarfjördur!. E. Iceland: frequent!. N. Iceland: Akureyri!.

Occurs rather commonly, but as a rule, not abundantly in SW., E. and probably also N. Iceland; in NW. Iceland it has not yet been found. It usually grows on the top of blocks of basalt and lava in small greyish cushions, and rarely on the dry gravelly soil of *Grimmia*-heaths. On the heath in Seljaland it occurred on blocks of basalt up to a height of about 400 metres; in Esja it has been found up to about 500 metres. Only sterile specimens have been found.

18. **Gymnomitrium concinnatum** (Ligthf.) Corda.

Commonly distributed over the whole of Iceland.

In the lowlands it is especially common in the lava-fields, where it grows both on the top of blocks of rock and in crevices and caves, generally mixed with other Hepaticæ such as *Lophozia alpestris*, *L. quinquedentata* and *Pleuroclada albescens* v. *islandica*; but it is also frequently met with in clefts mixed with other Bryophyta and creeping over stones. But it has its greatest distribution from about 300—400 metres upwards towards the snow-line, where it grows both on more or less damp ground and on rocks either in low, extensive cushions or mixed with other Bryophyta such as *Lophozia alpestris*, *L. ventricosa*, *Pleuroclada albescens*, *Dicranum Blyttii* and *D. fulvellum*, usually also woven into dense cushions of *Conostomum boreale*.

In NW. Iceland especially, where it is one of the most frequently occurring Bryophyta, it grows on gravelly flats on mountain heights in extensive carpets associated with *Anthelia nivalis*, *Alicularia minor*, *Polytrichum sexangulare* and the other above-mentioned Bryophyta. Near Seljaland, at about 650 metres, it was growing in great masses on weathered basalt rocks associated with *Marsupella emarginata*, *Polytrichum sexangulare* and *Dicranum Blyttii*.

Fruit not rare; it ripens, according to altitude, during June—July.

19. **Gymnomitrium varians** (Lindb.) Schiffner.

NW. Iceland: Dýrafjördur! (at an altitude of about 350 metres on damp gravelly ground; Reykjaheidi, in a lava-cleft!. Near Dýrafjördur it was growing abundantly in low, blackish-brown mats associated with *Anthelia nivalis* and *Alicularia minor* on ground saturated with melting snow.

20. **Gymnomitrium revolutum** (Nees) Phil.

NW. Iceland: Sugandafjördur! at an altitude of about 200 metres). It occurred here, on wet gravelly soil upon a slope, scantily among *Hypnum callichroum*, *Dicranum Starkei*, *Scapania uliginosa* and *Lophozia Floerckei*.

21. **Marsupella Funckii** (W. et M.) Dum.

E. Iceland: Hof!, in brownish-black cushions about one cm. high, in rock-clefts associated with *Lophozia alpestris* and *Dicranum Andersoni*; Seljaland! (at about 350 metres), on the ground between blocks of basalt and mixed with *Marsupella emarginata* and *Dicranum Blyttii*.

22. **Marsupella emarginata** (Ehrh.) Dum.

NW. Iceland: Dyrafjördur on damp rocks at an altitude of about 250 metres!. S. Iceland: Holt! at about 400 metres), on marshy ground among *Hypnum sarmentosum*, *Oncophorus virens*, etc.; Seljaland!, in several places from an altitude of 350 to 650 metres, both on gravelly soil and on rocks.

This species is recorded by Mörch from Iceland (figured in Flora Danica. tab 1945), and by Grönlund from Thingvellir and Hafnarfjördur. The specimen from Hafnarfjördur has proved to be *Anthelia julacea*. Mörch's specimens are not to be found in the collections.

23. **Marsupella aquatica** (Lindb.) Schiffner.

NW. Iceland: Kaldalon! by the bank of a small lake intermixed in a tuft of *Hypnum sarmentosum* and *H. exannulatum*; Isafjördur!, abundantly in an almost dried up river, at an altitude of about 250 metres.

24. **Alicularia scalaris** (Schrader) Corda.

Very common over the whole of Iceland.

Alicularia scalaris is one of the most commonly occurring Hepaticæ in Iceland, and is of almost equal frequency in the lowlands as in the higher mountainous regions. Fruit is rather common.

It grows especially on a somewhat damp substratum, both on rocks and on gravelly ground and also by streams and in bogs, sometimes as pale green or — in exposed localities — brownish mats, sometimes sprinkled in the tufts of other Bryophyta. On peaty ground it often forms extensive, continuous carpets in company with *Pogonatum urnigerum*. On warm clayey flats it also occurs abundantly, and forms together with *Haplozia crenulata* dense, reddish-brown or pale green mats along the warm water near both sulphurous and alkaline springs.

25. **Alicularia geoscypha** De Not.

Nardia minor (Nees) Arnell, *N. haematosticta* Lindb.

Commonly distributed all over Iceland and, as a rule, fruiting.

This species doubtless occurs as frequently in the lowlands as on mountain heights upwards to the limit of plant-growth. It is generally met with on damp gravelly ground associated with other Hepaticæ, for instance by streams with *Cephalozia bicuspidata*, *Scapania subalpina*, *S. curta*, *Lophozia alpestris* and *L. Wenzelii*, or on damp gravelly ground on rocky flats with *Pohlia gracilis*, *P. commutata*, *Aongstroemia longipes* and several other species. On mountain heights, especially in NW. Iceland, it generally grows in company with *Anthelia Juratzkana* on gravelly flats irrigated by melting snow.

Var. *insecta* (Lindb.) K. M. was collected near Isafjördur (at about 300 metres alt.) together with the type.

Note. *Alicularia compressa* (Hooker) Nees is figured in Flora Danica, tab. 1772, fig. 2, and is recorded to have been found near Grönnefjord (?) by Mörch, but no specimens of it are to be found in the collections.

26. **Eucalyx subellipticus** (Lindb.) Breidler.

E. Iceland: Berufjördur!; Seydisfjördur!. N. Iceland: Hof near Eyjafjördur (O. D.)!; Öxnadalur. NW. Iceland: Kaldalon!; Laugarland!; Grunnavik (at about 350 metres alt.); Gnupsdalur!. W. Iceland: Gilsbakki: Esja, several places!; Kolvidarhól!. S. Iceland: Thingvellir, several places!. It has been collected everywhere in fruit.

It is no doubt rather common but often overlooked on account of its diminutive size and resemblance in habit to the far more frequently occurring small species of *Alicularia* and *Haplozia*, with which it is generally associated. It is usually found on damp gravelly ground, more rarely on damp rocks or in lava-clefts; now and then in unmixed tufts, but generally mixed with *Alicularia scalaris* and *A. geoscypha*, *Scapania curta*, *Dicranella crispa*, *Pohlia* spp., etc. Near Hof it grew mixed with *Haplozia pumila*; in Almannagjá it occurred in many places at the bottom of clefts or on humus-covered ledges associated with *Lophozia alpestris*, *Alicularia geoscypha* and *Scapania subalpina*. Near Seydisfjördur it occurred creeping over stones by the river and mixed with *Haplozia atrovirens*.

27. **Haplozia crenulata** (Sm.) Dum.

Nardia crenulata.

Near Geysir (Mörch; Stp.!); figured in Flora Danica, tab. 1774, fig. 1, "in uliginis Islandiæ frequens, A. Mörch." Common near all the hot springs in Reykholtdalur!, Reykirdalur!, on Biskupstungur!, on Reykjanes (Ostf.)!, near Laugarvatn!, in Lundurreykjadalur! and near Myvatn!. It was found also in W. Iceland: Borgarnes!, at several places along the road; Lækjarmot!, on wet ground in bogs. NW. Iceland: Laugarland!, on boggy ground.

Haplozia crenulata is in Iceland a decidedly warm-soil species which is hardly absent from any hot spring, whether sulphurous or alkaline. It grows there in abundance on warm clayey flats which have a temperature of 20°—35°, near Mývatn even at a temperature of about 40°. It occurs far more rarely on peaty soil, and then only scantily. Curiously enough, these habitats, also, are situated in districts where there are hot springs. Near Laugarland, for instance at the edge of the marsh, there is a small spring with lukewarm water, but the heat from it can exert no influence on *Haplozia crenulata*, nor does the latter occur in the immediate neighbourhood of the spring.

This species varies considerably in colour, size, thickness of the cell-walls and as regards the leaf-margin. In the low, reddish-brown forms which grow on warm ground nearest to the hot water the cell-walls are more highly thickened, and are especially distinctly collenchymatous, while the more vigorous, green forms which grow at some distance from the spring on more boggy ground, among other Bryophyta, have thin-walled cells which are indistinctly collenchymatous. The marginal cells are sometimes large and thick-walled, sometimes scarcely larger than the other leaf-cells and then only slightly thickened; in such cases it may be difficult to distinguish the plant from the forms of *Haplozia sphærocarpa* and *Alicularia scalaris* with which it is often found associated. Under high magnifying powers the marginal cells will however always be seen to be somewhat papillose, which is never the case in *Alicularia*.

28. **Haplozia sphærocarpa** (Hook.) Dum.

S. Iceland: Grafarbakki near a hot spring F. !; Thorlákshver among *Catharinea undulata*!; Sydri Reykjahver among *Oligotrichum hercynicum*!; Laugarvatnshver among *Sphagnum cymbifolium*!; Isafjördur on a rocky flat (300—400 metres above sea-level)!.

All the forms found, which are quite sterile, stand slender and erect among other Bryophyta and must doubtless be referred more particularly to the type.

This species, like its companion *Oligotrichum*, has a very peculiar distribution in Iceland, having two such widely different areas of distribution as the warm clayey flat with a temperature of 25°—30° and the rocky flat.

Note. A liverwort is figured in Flora Danica, tab. 2195, under the name *Jungermannia pumila*; it is recorded to have been found by Mörch near Lejrá. Lindberg, in his critical revision of the mosses in Flora Danica, refers it to *Jungermannia cæspiticia*, but the specimens are not to be found in the collections.

29. **Haplozia cordifolia** (Hook.) Dum.

Very common and often fruiting richly. It grows especially on rocks, in or by waterfalls; or submerged in rivers, where it sometimes covers large surfaces of the firm rocky bottom with its blackish-green mats. But it may also be met with on irrigated gravelly ground or in

moss bogs associated with species such as *Philonotis seriata, Chiloscyphus polyanthos* v. *fragilis* and *Scapania undulata.*

It is most widely distributed in the lowlands up to a height of about 300 metres, but is also frequently met with up to about 500 metres, for instance in Esja.

30. **Haplozia riparia** (Tayl.) Dum.

Vestmannaey. S. Iceland: Flokastadagil!; Klitnafoss!; Barkarstadr!; Holt!.

In all the above-mentioned localities the plant was growing on tuff and was, as a rule, fruiting. On Vestmannaey it was growing on "Stora Klit," on the surface of dripping tuff-rocks facing north, associated with *Hymenostylium curvirostre, Hypnum filicinum* and *Anomobryum filiforme.* In S. Iceland it is fairly common in damp ravines on Fljotshlid and below Eyafjall, and grows there partly associated with the above-mentioned species, partly in company with *Fegatella conica, Preissia commutata, Bryum oenum,* etc.

Haplozia riparia is recorded by Grönlund from Brynjudalur and Seydisfjördur, but the specimens from these localities must be referred to *Haplozia atrovirens.*

31. **Haplozia atrovirens** (Schl.) Dum.

Common on damp rocks, more rare on damp gravelly ground.

It occurs sometimes in low, blackish-green cushions, sometimes intermixed in the tufts of other Bryophyta. Male plants and fruiting plants are frequently met with, sometimes in separate tufts, sometimes mixed in the same tuft. Like *Haplozia cordifolia* it occurs most commonly to a height of about 300 metres, but is also frequently met with up to about 500 metres. Var. *sphærocarpoidea* (De Not. Mass. has a distribution similar to that of the type, and occurs in the same localities as the latter. Both forms pass evenly into each other.

The cuticle of the leaves, in the majority of the plants, is more or less distinctly rough with striæ, and rarely smooth.

32. **Haplozia pumila** (With.) Dum.

N. Iceland: Hof, near Eyjafjördur (O. D.)!. It was growing there intermixed in a tuft of *Eucalyx subellipticus.*

The rest of the specimens referred by Grönlund and Jensen to this species all belong to *Haplozia atrovirens.*

33. **Jamesoniella autumnalis** (De Cand.) Steph.

S. Iceland: Nuphlidarháls (Stp.)!.

34. **Sphenolobus minutus** (Crantz) Steph.

SE. Iceland: Lon, scantily among *Sphagnum rubellum* and *Fissidens osmundoides.* NW. Iceland: Hesteyri, in a tuft of *Dicranum elongatum.* W. Iceland: Grund in Skorradalur, among *Polytrichum strictum.*

This plant was first found by Mörch and figured in Flora Danica, tab. 2190, without a more precise notification of its habitat.

Grönlund's record of the occurrence of this species in Esja is due to an erroneous determination.

35. **Sphenolobus saxicola** (Schrad.) Steph.

"in Islandia leg Mörch" (M. B. H.)!. Figured in Flora Danica, tab. 2693, fig. 1, but no habitat is given.

36. **Sphenolobus politus** (Nees) Steph.

Isafjördur! c. coles.

It was growing there in several localities at an altitude of about 200—300 metres, sometimes along the banks of streams associated with *Harpanthus Flotowianus*, sometimes in bogs associated with *Sphagnum teres, Lophozia quinquedentata* and *L. Kunzeana.*

37. **Lophozia quinquedentata** (Huds.) Cogniaux.

Very common all over Iceland.

Lophozia quinquedentata is doubtless the liverwort of most frequent occurrence. It is met with, up to the snow-line, in all possible localities which are somewhat damp, now and then in unmixed tufts, but generally woven into the tufts of mosses. Female plants and fruit are rather rare, male plants are far more frequent; plants bearing gemmæ are also often met with.

It varies extremely as regards size, habit and leaf-form. The extreme members of the variation-series are the large var. *turgida* Lindb. which is common on boggy ground and t e delicate, often only one mm. broad, var. *tenera* C. Jens. which is frequent in dry localities, as for instance on humus-covered rocks and in lava-fields.

38. **Lophozia lycopodioides** (Wallr.) Cogniaux.

Almost as common as the preceding species on drier ground. It is found especially on stony or grass-covered slopes, creeping over humus-covered rocks, in birch coppices, and on the top of knolls in bogs, sometimes in large, unmixed, yellowish-green tufts, sometimes intermixed with other Bryophyta. Only sterile specimens have been found. It varies considerably in size. Delicate forms (var. *parvifolia*), often only one mm. broad, grow on dry rocks woven into the tufts of other Bryophyta, while the large, vigorous forms are especially met with on slopes overgrown with *Hylocomium.* Now and then forms also occur which approach very closely to *Lophozia Hatscheri* (Evans) Steph. But plants which can with certainty be referred to this species have not been found in Iceland.

Lophozia lycopodioides is most widely distributed in the birch-zone, up to about 400 metres above sea-level, and is especially wide-spread towards the north-west while it occurs more sparingly in S. Iceland.

In the district around Isafjördur it is also met with abundantly on the rocky flat, 500—600 metres above sea-level, and near Akureyri it was collected, although sparingly, near the snow-line (at about 770 metres alt.).

39. **Lophozia Floerckei** (W. et M.) Schiffner.

NW. Iceland: Dýrafjördur; Isafjördur; Hesteyri!; Grunnavik!; Kaldalon!; Arngerdareyri!. SW. Iceland: Svinahraun!.

In the majority of the older lists of Bryophyta from Iceland *L. Floerckei* is recorded from rather a considerable number of habitats, but all the specimens from these habitats preserved in the Botanical Museum in Copenhagen, have been wrongly determined; the majority of them must be referred to *Lophozia lycopodioides*. The only specimen in the collections, correctly determined, was gathered by Mörch, but no habitat is given.

This species has a very peculiar distribution as it is very common in the north-west, and is also found abundantly on the highly situated Svinahraun in the south-west (about 300 metres), but has not otherwise been found in Iceland. In NW. Iceland it ascends from the low land to the rocky flat, but is most frequently met with from 200 to 400 metres above sea-level. There it grows on fairly dry ground in bilberry heaths, both on the ground and creeping over rocky blocks, associated with *Dicranum fuscescens*, *D. scoparium*, *D. molle*, *Lophozia lycopodioides* and *L. quinquedentata*. At a higher level it grows especially on the *Salix-herbacea*-flats, associated with *Lophozia ventriosa*, *L. alpestris*, *Dicranum Starkei*, *Pleuroclada albescens*, etc., but also occurs on a more damp bottom.

In Svinahraun it occurred commonly between the lava-blocks and also in a damp depression at the edge of the lava-field, associated with *Polytrichum commune*.

40. **Lophozia quadriloba** (Lindb.) Evans.

E. Iceland: Berufjördur!; Lon!; common near Seydisfjördur; Vallanes!. N. Iceland: Husavik!; Akureyri!; about Eyjafjördur (O. D.; !). NW. Iceland: Kaldalon!; Isafjördur!. W. Iceland: Melar (Grl. !; Esja, several places!. S. Iceland: Svinahraun!; Holt!; Hornafjördur!. The Vestmannaeyjar!.

This plant is no doubt common, but usually it occurs so scantily that it is only found by close search of the Bryophyte collections under the microscope. It grows both on damp humus-covered rocks and on boggy ground, from the low land upwards to the mountain-tops. Thus, near Isafjördur it was collected at about 440 metres. Near Seydisfjördur it is frequent up to about 500 metres and near Akureyri it was found on cliffs at an altitude of 900 metres.

Lophozia quadriloba hardly occurs in unmixed tufts, but always mixed with other species, for instance with *Dicranum* spp. or on rocks among *Distichium montanum*, *Tortella fragilis*, *Oncophorus*, or with other Hepaticæ such as *Cephalozia*, *Lophozia alpestris* and *Aneura pinguis*. On

boggy ground it is found interwoven with *Hypnaceæ* in their tufts, but rarely in those of *Cinclidium*, *Lophozia Kunzeana* or other bog-mosses.

The majority of the specimens investigated are small and delicate, and must partly be referred to forma *heterophylla* Bryhn et Kaalaas, and partly to forms transitional between this and the type. Only sterile plants have been found.

41. **Lophozia Kunzeana** (Hüb.) Evans.

Very common in bogs, on damp rocks, damp gravelly ground, etc.

It is most widely distributed in bogs where it grows woven into. or creeping over tufts of other Bryophyta, especially *Sphagnum*. Near Akureyri, for instance, it commonly occurs in bogs up to a height of about 600 metres. In S. Iceland it is rather rare in the bogs of the lowlands, but is met with abundantly at an altitude of 200—400 metres.

42. **Lophozia barbata** (Schmid.) Dum.

E. Iceland: Árbær, among *Grimmia canescens* (H. J.)!. W. Iceland: Bjarnarhöfn (H. J.)!; Berserkjahraun (H. J.)!; Reynivellir (Grl.)!; Nordredalur in the district of Borgarfjördur!; Álafoss!.

In addition to the above-mentioned localities Grönlund and Helgi Jónsson record this species from several other localities, but some of the specimens which have been investigated proved to be wrongly determined (being, as a rule, forms of *L. lycopodioides*), so only those localities are enumerated here from which authentic specimens are known.

L. barbata appears to be rather rare. It has as a rule been collected, intermixed rather sparingly in tufts of other Bryophyta especially *Grimmia* and *Hylocomium* spp. and belongs to the *Grimmia*-heaths or to the mossy bottoms of birch coppices; thus in Nordredal it frequently occurred in birch coppices among *Hylocomium* spp., *Dicranum scoparium*, *Ptilidium ciliare*, etc.

Note. *Lophozia gracilis* Schl. Stephani is recorded from several localities, but all the specimens which have been investigated have been wrongly determined, being mostly *Lophozia lycopodioides* var. *parvifolia*.

43. **Lophozia ventricosa** (Dicks.) Dum.

Common on more or less damp ground, both boggy and gravelly ground, and on rocks on mountain heights.

This species is very common especially in NW. Iceland, and occurs there on a heathy bottom woven into tufts of *Dicranum*; along the banks of streams associated with *Harpanthus*, *Lophozia quinquedentata* and *Cephalozia bicuspidata*; and in bogs among *Spagnum*. It appears. on the whole, to be more frequent the higher it ascends; undoubtedly its main distribution is from a height of about 300—400 metres upwards.

Var. *porphyroleuca* (Nees) Hartm. is likewise commonly distributed and occurs, for instance, frequently interwoven with *Conostomum* in its compact tufts, and also in tufts of *Dicranum* and *Sphagnum* on damp ground.

It is hardly possible to draw any distinct boundary line between this form and the type, the thickenings of the leaf-cells showing all transitional stages from quite thin-walled to decidedly collenchymatous cells, and the colour also varying according to the habitat. Fruit is rare; gemmæ are as a rule present.

Var. *confertifolia* Schiffn. syn. *Lophozia confertifolia* Schiffner. Plants agreeing exactly with the description of this form and with the figure in Rabenhorst's Kryptogamenflora, fig. 314, occur rather commonly on damp gravelly soil in NW. Iceland associated with all the transitional forms of *L. ventricosa*; I think they can only be regarded as Alpine forms of the present species.

44. **Lophozia Wenzelii** (Nees) Steph.

E. Iceland: Seydisfjördur!; Vallanes!. N. Iceland: Tverá in Öxnadalur!. NW. Iceland: Isafjördur, (at about 200 metres alt.)!. SW. Iceland: Svinaskard (at about 400 metres alt.).

It grows on wet gravelly soil or peat, especially along streams where it forms low, dense carpets or grows mixed with *Alicularia scalaris*, *Dicranella crispa*, *Distichium inclinatum* and other Bryophyta. Near Isafjördur it was growing by a small stream together with *Sphagnum squarrosum*.

45. **Lophozia alpestris** (Schleich.) Evans.

Very common all over Iceland.

It generally grows woven into tufts of other Bryophyta, but now and then forms tufts by itself. It is found on almost every kind of substratum, from the sea-level to mountain heights. It occurs most frequently on rocks, especially those which are somewhat damp, but is also met with on damp ground along the bank of streams, on the gravelly flats of mountain heights, in lava-clefts and woven into the moss-carpets of *Grimmia*-heaths.

Fruit and calyces occur rarely and have been found only in NW. Iceland: Gnupsdal! and in S. Iceland: Seljaland (at about 350 metres)!; Svinahraun!. Male plants are rather common, and gemmæ are very often present.

46. **Lophozia excisa** (Dicks.) Dum.

S. Iceland: Reykir!; fr.

It grows there on damp gravelly soil by a small stream associated with *Eucalyx subellipticus*, *Scapania curta* and *Dicranella crispa*.

This species is recorded from Iceland by Mörch, but of the two specimens found in the collection in the Botanical Museum in Copenhagen under this name, one is *Lophozia ventricosa* var. *porphyroleuca* and the other *L. heterocolpos*.

Note. *Lophozia bicrenata* (Schmid.) Dum. is recorded to have been found near Krisuvik by Steenstrup, but the packet contained only a mixture of several other species of *Lophozia*.

47. **Lophozia Schultzii** (Nees) Schiffner.

E. Iceland: Seydisfjördur; Vestdalur (at an altitude of about 200 metres)!. N. Iceland: Akureyri!. W. Iceland: Stykkisholmur!.

It was collected everywhere only in small quantities together with bog-mosses such as *Hypnum revolvens*, *H. stellatum*, *Mnium Seligeri*, etc.; it was as a rule sterile. Near Stykkisholm it was collected in unmixed tufts with antheridia and young calyces.

48. **Lophozia Mülleri** (Nees) Dum.

Common, but occurred almost always in small quantities intermixed in tufts of mosses.

This species is most frequent in the lowlands up to about 300-400 metres above sea-level, but it also occurs at great altitudes in the Alpine region, for instance, at about 600 metres on Berufjördurskard. It is almost always sterile.

Lophozia Mülleri occurs on very different substrata, most frequently on rocks, but it may also be found on damp ground along streams, or even in bogs. It varies exceedingly in size according to the degree of dampness of the habitat. Xerophilous forms from rocks are usually small and delicate, while bog forms which grow in the tufts of *Hypnaceæ* are considerably larger and often approach so closely to *L. Hornschuchiana* that they are difficult to distinguish from the latter. On the damp, vertical sides of the clefts of the tuff rocks of S. Iceland, for instance on Fljotshlid, a vigorous, blackish-green form is frequently met with forming large, pure mats.

49. **Lophozia Hornschuchiana** (Nees) Macoun.

Jungermannia bantryensis, Hooker.

E. Iceland: Seydisfjördur, frequent up to about 400 metres!. N. Iceland: Akureyri!; Hof; Eyjafjördur (O. D.)! c. coles. NW. Iceland: Isafjördur. W. Iceland: Dalsmýnne in Nordredal!; Mulakot!; Botnsdalur!; Reykjavik!; Kollafjördur.

Occurs rather frequently, but as a rule scantily, on boggy ground among mosses (*Hypnum*, *Sphagnum*, etc.), more rarely on stones in rivers. In Nordredal, for instance, it was found abundantly in a small river on submerged stones.

50. **Lophozia heterocolpos** (Thed.) Howe.

N. Iceland: Spönsgerde near Eyjafjördur (O. D.)!. NW. Iceland: Bæir!; Kaldalon!. SW. Iceland: Hafnarfjördur!; Esja!, at an altitude of about 400 metres; Thingvellir (Grl.;!).

In all the above localities it was found on humus-covered rocks, especially in clefts. Near Kaldalon it grew on damp rocks woven into a tuft of *Meesea trichoides* and *Dicranella subulata*; on Esja it grew upon damp tuff-rocks. In Thingvallahraun it is widely distributed in clefts

and caves in the lava-fields, usually mixed with *Blepharostoma trichophyllum*, *Amblystegium Sprucei*, *Diplophyllum albicans* and *Plagiothecium denticulatum*. The characteristic gemmiferous shoots occur always, but plants in fruit have not been collected.

51. **Gymnocolea inflata** (Huds.) Dum.

"In Islandia" leg. Mörch! and figured in Flora Danica, tab. 1945, fig. 2; SW. Iceland: Krisuvik (Stp.)!; Laugarvatn (Stp.! ; Reykholt Grl.;!); Reykirdalur!; Kolvidarhol!. NW. Iceland: Laugarland!.

Grönlund records this species from several other localities besides those mentioned above, but the specimens in the Botanical Museum in Copenhagen are all wrongly determined and must be referred to *Lophozia Mülleri* or to *L. alpestris.*

In Iceland *Gymnocolea inflata* is a decidedly warm-soil plant which, with the exception of a single locality, was found exclusively on the steaming clayey flats around hot springs in SW. Iceland. Near Laugarland it was growing rather sparingly in a bog. *Haplozia crenulata* was growing in its neighbourhood, and as there was a small spring with lukewarm water at the edge of the bog it is possible that the occurrence of the two species is connected with the spring, although there was no characteristic vegetation around the spring, but only the common bog-plants.

In Reykirdalur, where it is found in abundance near almost all the hot springs, it forms extensive brownish-black or almost entirely black mats on warm ground with a temperature of as much as 40° around fumaroles or on slopes stretching down towards the boiling hot basins. At some distance from the spring it will grow woven into the tufts of *Polytrichum commune* or mixed with *Cephalozia bicuspidata* which likewise occurs in brownish-black forms.

It was collected with calyces only at Laugarvatnshver.

52. **Plagiochila asplenioides** (L.) Dum.

Very common everywhere.

Plagiochila asplenioides occurs on almost every substratum, on damp or on dry rocks, in bogs, on earth, etc. It is most frequent up to a height of about 300 metres above sea-level, but often occurs as far upwards as about 600—700 metres. Usually it grows intermixed in the tufts of other Bryophyta, more rarely it forms tufts by itself. The majority of the specimens which have been collected are small, only 1—2 mm. broad, with leaves slightly dentate or entire. Larger forms with leaves typically dentate occur mostly on somewhat damp ground, for instance among stones on a talus of loose blocks and debris (Urd) or in caves. Only sterile specimens have been found.

53. **Leptoscyphus anomalus** (Hook.) Lindb.

E. Iceland: Stöd (H. J.)!.

54. **Lophocolea cuspidata** Limpr.

Vestmannaey!. S. Iceland: Holt!.

On Vestmannaey it was found in several places at the base of cliffs and in specially large quantities in Heljusdal where it grew abundantly among stones on an Urd usually mixed with *Eurynchium*, *Stockesii* and *Mnium undulatum*. Near Holt it was found in several places, but everywhere only in small quantities in clefts of tuff-rocks, woven into the tufts of mosses. Only sterile specimens have been found.

55. **Lophocolea minor** Nees.

N. Iceland: Hálsskógur (O. D.)!. S. Iceland: Reykirdalur!; Vestmannaey: Heljusdal!.

In Reykirdalur it was growing rather sparingly on a grass-covered slope stretching down towards a stream. On Vestmannaey it occurred in several places associated with *L. cuspidata* sometimes intermixed in its tufts. In all the localities only sterile specimens were collected, but bearing the characteristic gemmæ.

56. **Chiloscyphus polyanthus** (L.) Corda.

Common in wet localities or in water, on gravelly ground and occasionally in bogs and on wet rocks. Only sterile specimens were found.

It occurs sometimes in unmixed cushions, which are usually blackish-green in colour in water and yellowish-green in boggy ground, sometimes mixed with other Bryophyta such as *Marchantia*, *Philonotis*, *Dicranella squarrosa* and *Mnium* spp. It is most widely distributed in the lowlands up to about 300 metres and does not appear to ascend much higher than 400 metres.

The typical form was collected only in S. Iceland on damp tuff-rocks near Holt. All the other plants which have been investigated belong to var. *fragilis* (Roth) K. M. It varies considerably as regards size and colour, but the form of the leaves and the size of the leaf-cells are almost always the same.

Note. *Chiloscyphus pallescens* is recorded from several places by Mörch, Grönlund and Helgi Jónsson, but all the specimens referred to this species belong to *Chiloscyphus polyanthos* var. *fragilis*.

57. **Harpanthus Flotowianus** Nees.

E. Iceland: Seydisfjördur, several places!. N. Iceland: several places around Eyjafjördur (O. D.)!; Stadr near Hrútafjördur!. NW. Iceland: Dýrafjördur; Sugandafjördur; Isafjördur; Grunnavik; Kaldalon; Arngerdareyri!. W. Iceland: Olafsdalur in Dalasýsla (H. J.)!; Esja, several places!.

In NW. Iceland this species is of the most frequent occurrence among all the Bryophyta and is met with everywhere on wet ground up to a height of about 300 metres above sea-level. In the other parts of the country it is wanting or rare; on Esja it is however rather fre-

quent. It occurs both in bogs and along the banks of streams, and also on inundated gravelly ground, usually intermixed in tufts of mosses such as *Cinclidium*, *Mnium cinclidioides*, *Sphagnum* and *Hypnum* spp.; also on wet gravelly soil associated with *Lophozia quinquedentata*, *Cephalozia bicuspidata* and other Hepaticæ. Only sterile specimens have been found.

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58. **Cephalozia bicuspidata** (L.) Dum.

Very common on earth, damp gravelly soil, humus-covered rocks, and in bogs up to a height of about 600 metres above sea-level, especially in NW., N. and in parts also of E. Iceland, while it appears to be more rare in S. Iceland. It grows partly in large cushions, for instance on damp ground by streams, partly intermixed in tufts of mosses especially *Sphagnum* and *Dicranum* spp. and thrives best on a somewhat damp substratum. Found as a rule in fruit. It varies considerably as regards size and colour.

Var. *Lammersiana* (Hüb.) Breidler grows on very wet ground, for instance along banks of streams, where it forms large green mats in association with other Hepaticæ. It is especially common in NW. Iceland. The bog-forms, which grow erect among *Sphagnum*, are slender with spreading leaves. On damp slopes a dark-brown-to-black form frequently occurs, often forming very extensive carpets; it corresponds most closely with var. *Loeskeana* (Schiffner) K. M., in previous lists it was referred to var. *Lammersiana*. At the head of deep lava-caves and at the bottom of lava clefts it occurs in association with *Alicularia scalaris* as much elongated shade-forms.

Note. *Cephalozia Francisci* is recorded by Mörch from Hafnarfjördur, but the specimen in the Botanical Museum is *C. bicuspidata*.

59. **Cephalozia ambigua** C. Mass.

NW. Iceland: Laugarland, fr.!.

It grew there in small brownish tufts on the damp ground at the bottom of the valley.

60. **Cephalozia pleniceps** (Aust.) Lindb.

Common in all parts of Iceland except in the southern part, where it appears to be rare. It is especially common in NW. Iceland and forms there one of the most frequently occurring Hepaticæ.

It occurs especially on damp ground and in bogs, woven into tufts of *Sphagnum*, *Dicranum* and *Mnium hornum* or associated with *Lophozia Kunzeana*, *L. quinquedentata* and other Hepaticæ and as a rule bears calyces or fruit. It occurs most frequently up to a height of about 300 metres, but it is also often met with at far greater altitudes.

Var. *macrantha* (Kaalaas et Nichols.) K. M. is widely distributed on wet ground, and grows in association with similarly elongated forms of

C. bicuspidata and *Cephaloziella Hampeana*, woven into the tufts of *Sphagnum* spp., but is as a rule sterile.

Note. *Cephalozia connivens* is recorded by Mörch and Grönlund as found in Iceland, but all the specimens which have been investigated belong to *C. pleniceps*.

61. **Cephalozia media** Lindb.

N. Iceland: Arnarfellsaurar (St.;!); NW. Iceland: Grunnavik!, intermixed in tufts of *Dicranum fuscescens*.

62. **Pleuroclada albescens** (Hook.) Spruce.

E. Iceland: Seydisfjördur!, common above a height of about 400 metres. N. Iceland: Akureyri!, common above 500 metres; Hestahraun (St.)!. NW. Iceland: Very common above 300 metres!. Var. *islandica* (Nees) Spruce. N. Iceland: Reykjaheidi!. S. Iceland: Thingvallahraun (Mörch; Stp.; Grl.;!); Hafnarfjördur!.

The typical form is no doubt common on mountain heights, at any rate in N., NW., and E. Iceland. In S. Iceland it has not yet been found. On mountain heights it grows on stony flats associated with *Dicranum* spp. (*D. Starkei*, *D. molle* and *D. fuscescens*), *Lophozia* spp. and *Cesia concinnata* or associated with *Polytrichum sexangulare*, *Lophozia ventricosa*, *Cesia concinnata*, etc., on *Salix-herbacea*-flats.

The variety belongs especially to the lava-fields and grows there at the bottom of deep clefts, creeping over blocks of lava, often in abundance. It occurs there either in large whitish-green cushions or mixed with *Hylocomium* spp., *Rhacomitrium hypnoides*, *Polytrichum alpinum*, *P. sexangulare*, *Lophozia* spp., etc. Only sterile specimens of each form have been found.

63. **Cephaloziella Hampeana** (Nees) Schiffn.

Very common, but occurs only as scattered shoots intermixed in the tufts of mosses, sometimes, however, also in tiny, yellowish-green, brownish or reddish tufts upon these.

It occurs on highly different substrata. On rocks and on earth it grows in tufts of *Dicranum* spp., *Ditrichum flexicaule*, *Distichium montanum*, *Tortella fragilis*, etc.; in bogs it has been found woven into tufts of *Sphagnum*, *Sphaerocephalus palustris*, *Hypnaceæ*, *Oncophorus* spp. and several others. Bog-forms, with elongated stems and widely spreading, very much projecting leaves, agreeing most closely with var. *erosa* Warnst., occur very commonly in *Sphagnum* cushions.

The leaf-tissue varies very considerably, the leaf-cells, even on the same plant, being sometimes quite thin-walled, sometimes more or less thickened; the leaves also are more or less outspread, so that all possible transitional forms between this species and *Cephaloziella rubella* are known.

64. **Cephaloziella rubella** (Nees.) Warnst.

Typical specimens of this species were collected in the following localities:

S. Iceland: Hornafjördur!. E. Iceland: Seydisfjördur!. N. Iceland: Hafrardalur (St.)!; Akureyri!, at an altitude of about 500 metres!; Hof (O. D.!). SW. Iceland: Kollafjördur!. S. Iceland: Holt!.

It was found everywhere woven into tufts of *Sphagnum* spp. and *Dicranum* spp. (*D. fuscescens* and *D. angustum*) and usually mixed with *Cephalozia bicuspidata* and *Lophozia* spp., now and then also with *C. Hampeana*. Near Isafjördur it grew sparingly in a tuft of *Mnium hornum*, which was densely interwoven with *Cephalozia pleniceps*. It was collected everywhere in fruit.

C. rubella is an uncertain species which when sterile is in many cases hardly distinguishable from *C. Hampeana*.

C. divaricata and *C. bifida* are recorded from several places in Iceland, but the specimens belong either to *C. Hampeana* or to *C. rubella*. Grönlund's *C. divaricata* from Melar is *Lophozia quadriloba*.

65. **Odontoschisma Sphagni** (Dicks.) Dum.

W. Iceland: Snældubeinstadahver in Reykholtdalur!.

It was found in the above locality in small quantity woven into a tuft of *Sphagnum rubellum* on a warm substratum.

This species is recorded from Iceland in several old lists and is figured in Flora Danica, tab. 2251 (leg. Mörch), but all the specimens found in the collections under this name are those of *O. elongatum*.

66 **Odontoschisma elongatum** (Lindb.) Evans.

"In Islandia" (Mörch!). E. Iceland: Hof!; Lon!; frequent near Seydisfjördur!. N. Iceland: Hvarf (St. !; Akureyri!. W. Iceland: Budahraun (H. J.)!; Grund in Skorradalur!; common around Reykjavik!. S. Iceland: Holt! at an altitude of about 400 metres.

It grows usually woven into tufts of bog mosses such as *Sphagnum*, *Hypnum* and *Oncophorus* spp., *Meesia trichoides*, *Lophozia Kunzeana*, more rarely upon moss-tufts or on wet ground, in small brownish tufts. Only sterile specimens have been found.

A specimen collected by Mörch, having tiny, inconspicuous underleaves and less thickened cell-walls bearing fine warts, forms a transitional form to *O. Sphagni*.

67. **Odontoschisma denudatum** (Mart.) Dum.

W. Iceland: Braudarholt near Reykjavik! ♂.

It grew in the above locality on boggy ground among other Bryophyta.

68. **Odontoschisma Macouni** (Aust.) Underwood.

S. Iceland: Bergarfoss near Hornafjördur!; E. Iceland: Grottafoss near Seydisfjördur! at an altitude of about 200 metres. N. Iceland: Hof (O. D.)!. SW. Iceland: Svinahraun!.

This plant grows partly in small unmixed tufts, partly mixed with other Bryophyta such as *Anoectangium lapponicum, Distichium montanum, Pohlia cruda, Blepharostoma trichophyllum* on damp humus-covered rocks. In Svinahraun it grew in lava-clefts filled with humus.

69. **Calypogeia Trichomanis** (L.) Corda.

N. Iceland: near Mývatn (Grl.!); Reykjahlid!. W. Iceland: near several hot springs in Reykholtdalur!; Tunguhver (probably Deildatunguhver) (Grl.;!); Kollafjördur!. S. Iceland: Laugaráshver!; Geysir!. Moreover, Grönlund records this species from Hvammur, but no specimens of it are to be found in the collections.

The plant grows in all the above localities on a warm substratum. Near Reykjahlid it covered the roof of a lava-cave which had a temperature of about 25°. In the other localities it occurred on a warm damp substratum woven into mosses such as *Sphagnum, Hypna* and *Polytrichum*, or in pale green to brownish cushions above them. In Reykholtdalur where it occurred abundantly in several localities, the temperature in the tufts was from 25° to 27°.

70. **Lepidozia setacea** (Web.) Mitten.

S. Iceland: Merkjáfoss (Feddersen)!.

It was found very sparingly in the above locality associated with *Cephalozia pleniceps* and woven into a tuft of *Dicranum scoparium*.

Fam. PTILIDIOIDEÆ.

71. **Blepharostoma trichophyllum** (L.) Dum.

Very common from the lowlands up to about 500—600 metres above sea-level.

This species rarely forms unmixed tufts, but grows almost always woven into tufts of other species and is met with in the most varied localities, on boggy ground and damp gravelly ground along rivers, in lava-fields, on damp rocks, and especially in abundance in rock-caves where it often covers the roof and walls in association with *Amblystegium Sprucei*, with a thin dark-green layer.

Fruit occurs rather rarely; but it is found plentifully in Almannagjá!, and near Hof in N. Iceland (O. D.)!.

72. **Chandonanthus setiformis** (Ehrh.) Lindb.

In the herbarium of the Botanical Museum there is a specimen, labelled by Mörch "In Islandia, among *Trichostomum canescens*, Aug. 1820."

73. **Anthelia julacea** (L.) Dum.

Common in the lowlands on damp gravelly ground and creeping over wet stones in streams, occasionally also on damp boggy soil; fruit is not rare. It does not appear to ascend higher than about 400 metres above sea-level.

74. **Anthelia Juratzkana** (Limpr.) Trevis.

Anthelia nivalis (Sw.) Limpr. ex. p.

Very common on damp gravelly flats irrigated by melting snow, somewhat rarer on damp gravelly ground along streams or on damp rocks.

This plant has its main distribution on mountain heights where, on the clayey or gravelly flats next to the snow-covered areas, it forms large, continuous carpets of a peculiar bluish-black colour, often mixed with *Salix herbacea* or with other Bryophyta such as *Alicularia geoscypha*, *Lophozia ventricosa* and *Polytrichum sexangulare*. In NW. Iceland, where the snow on slopes with a northern exposure may remain during the greater part of the summer, these *Anthelieta* often descend to sea-level. The plants growing on damp rocks or gravelly ground in lower levels differ from the typical form from mountain heights in being lighter in colour, usually yellowish green, and in the tufts being as a rule higher, with less close-set leaves; or it may also grow intermixed with other Bryophyta especially Hepaticæ.

A. Juratzkana and *A. nivalis* are so closely related that in many cases it is impossible to determine them when sterile. While the typical *A. Juratzkana*, as it occurs in abundance on mountain heights, is very characteristic because of its extensive low carpets, quite typical specimens of *A. julacea* are far more rarely met with on the damp soil of the lowlands. Of far more frequent occurrence are forms which pass, more or less, in habit, size of leaf-cells and thickness of cell-walls from *A. julacea* towards *A. Juratzkana*.

75. **Ptilidium ciliare** (L.) Hampe.

Very common both on dry and on somewhat damp ground.

The plant grows both among *Hylocomium* spp. on slopes and intermixed in heaths of *Rhacomitrium hypnoides* and *R. canescens* on more or less damp rocks coated with soil, and also in clefts in lava-fields and on knolls in bogs. It occurs most frequently in low-lying regions up to about 300—400 metres, but may also occasionally be met with on mountain heights. Only sterile specimens have been found.

Fam. SCAPANIOIDEÆ.

76. **Diplophyllum albicans** (L.) Dum.

"In Islandia" (Mörch!). W. Iceland: Budahraun (H.J.!); Hafnarfjördur (Grl.; H. J.;!); Svinahraun!; Mödruvellir in Kjos!. S. Iceland: Thingvalla-

hraun (Grl.; Stp.;!); Krisuvik (Stp.)!; Holt!; Reykirdalur!, at an altitude of about 260 metres.

Diplophyllum albicans is a plant characteristic of the lava-fields of West and South Iceland and occurs there in great abundance on vertical rock-sides in clefts and caves, while it appears to be entirely absent from the lava-fields of North Iceland. Outside the lava-fields it has been gathered only extremely sparingly among stones on heaps of debris at foot of cliffs (Urd). In Reykirdalur it grew scantily on a warm substratum among large blocks of basalt. Only sterile specimens have been found.

77. **Diplophyllum obtusifolium** (Hook.) Dum.

"In Islandiae montibus leg. Mörch" and figured in Flora Danica, tab. 1831, fig. 2. No specimens of it are to be found in the herbarium of the Botanical Museum. In the district of Seydisfjördur!, on a damp rock-face by the river it occurred in a small quantity in a tuft of *Dicranum molle* and *Lophozia Kunzeana*. In N. Iceland: Ásbyrgi!, it was found on the ground among fallen blocks of lava. Only sterile specimens have been found.

78. **Scapania subalpina** N. ab Es.

Common on damp ground along streams, on damp rocks, in clefts and on damp slopes of the low land. It does not appear to ascend much higher than about 300 metres.

♂ plants are very common; calyces and fruit occur occasionally.

The plant varies in having deeply toothed to almost entire leaves. It is usually green or yellowish-green in colour, but sometimes reddish or brownish to almost blackish-brown in more exposed localities.

79. **Scapania remota** Kaalaas.

N. Iceland: Akureyri!.

The plant, which agreed exactly with the description and figure in Karl Müller's Monographie der Lebermoosgattung Scapania, grew in the above locality, in a bog 400 metres above sea-level, intermixed in tufts of *Oncophorus virens*.

80. **Scapania irrigua** (Nees) Dum.

Very common on damp ground, in bogs, along streams and on damp rocks.

This species is most widely distributed in the lowlands up to about 300 metres above sea-level, but may also frequently be met with at high altitudes in the Alpine regions. In wet localities, especially in bogs, where it occurs everywhere woven into the tufts of other Bryophyta, it is usually yellowish green in colour. The leaves are entire or fewly toothed towards the apex with thin-walled or slightly collenchymatous cells. But occasionally vigorous, brownish-green forms

also occur with more highly thickened cell-walls. In somewhat drier localities it is usually brownish in colour and more compact with more deeply toothed leaf margins, sometimes almost as in *S. subalpina* and with more thick-walled cells. Small forms from damp sandy soil often constitute transitional stages to *S. curta*, while vigorous aquatic forms approach closely to *S. undulata*. A very vigorous form with leaves which were as deeply toothed as in *S. subalpina* was found in abundance in lava-clefts near Thingvellir.

♂ plants are common; calyces and fruit occur rather rarely.

Note. *Scapania compacta* is recorded by Grönlund from Esja, but the specimen in the Botanical Museum is really *Scapania irrigua*.

81. **Scapania uliginosa** (Sw.) Dum.

E. Iceland: Stöd (H. J.)!. NW. Iceland: Gnupsdal in Dýrafjördur!; Sugandafjördur!; Isafjardarheidi!; Dýnjandi!; Arngerdareyri.

With the exception of a single locality in E. Iceland this species was found only in NW. Iceland where it is rather common on very wet or irrigated soil along streams, often occurring in great abundance up to a height of about 400 metres. Near Arngerdareyri it grew abundantly in a bog in reddish-brown tufts associated with *Hypnum* spp. The leaf-form and habit in this form were typical, but the leaf-cells had brownish and rather thickened walls and a roughly granular cuticle.

The plant from Sugandafjördur differed from the type in its leaves being sometimes distantly toothed and the cells very slightly thickened at the angles, in which respects it approached *S. irrigua*.

82. **Scapania paludosa** C. M.

NW. Iceland: Gnupsdal in the district of Dýrafjördur, c. coles.! Grunnavik ♂!; Isafjördur ♂!.

In Gnupsdal the plant grew abundantly in the water in small streams, where it formed large, loose, green to brownish mats. The leaves were highly decurrent, with indistinct teeth or entire margins, and thin-walled cells.

Near Isafjördur and Grunnavik it grew on wet boggy ground. The leaves in both these forms were shortly decurrent and more or less toothed with a broadly reniform or (often in the same plant) cordate postical lobe which was occasionally furnished with a small point as in *S. irrigua*; the leaf-margin was often reflexed as in *S. undulata*; the cells were thin-walled, but towards the margin occasionally somewhat thick-walled. The commissure is typically short and strongly curved with broad wings.

83. **Scapania dentata** Dum.

Scapania purpurascens (Hook.) Pearson.

E. Iceland: Berufjördur!; Seydisfjördur!, common up to about 100 metres. Kirkjuból (H. J.)!. N. Iceland: Stora Gjá!. W. Iceland: Hvammur

Grl.)!; Esja!, common up to about 400 metres above sea-level; Hafnarfjördur!. S. Iceland: Krisuvik (Stp.)!; Krókr (H. J.)!; Almannagjá!; Holt!; Seljaland!; Austerhlid near Geysir!.

This species has its main distribution in E. and SW. Iceland and it has not been found in NW. Iceland. It grows especially on wet rocks and often in the water itself, but also on gravelly soil along the margin of streams. Thus, near Seydisfjördur it occurred abundantly along several rivers. In such localities it forms extensive reddish-brown cushions several centimetres deep.

On damp soil and on rocks it forms low cushions, green, rose-red or reddish-brown in colour. In the lava-fields near Hafnarfjördur and Thingvellir and in Stora Gjá it usually grew at the bottom of the comparatively dry caves and clefts in small, flat tufts of a peculiar yellowish-green or beautiful rose-red colour. Such forms from comparatively dry localities have always deeply-toothed leaves while the aquatic forms have less deeply-toothed, sometimes almost entire leaves, in which feature they approach *S. undulata* very closely. The cell-walls are however always more highly thickened than in the latter species, especially at the angles, and the postical lobe of the leaves are longer and narrower obovate (in *S. undulata* almost circular). ♂ plants and fruit are of frequent occurrence.

84. **Scapania undulata** (L.) Dum.

Very common on stones and gravelly soil in rivers, occasionally also on inundated ground in swamps and moss bogs.

This plant occurs most frequently in the low land up to about 300 metres, and forms there, especially creeping over stones in the shallow water along rivers, extensive growths in association with *Chiloscyphus polyanthus* var. *fragilis* and *Haplozia cordifolia*. Not rarely it is also met with at higher levels, for instance near Dyrafjördur, where it grew abundantly on slopes irrigated by melting snow, 400—500 metres above sea-level; and near Holt below Eyjafjall, where it was found abundantly in a stream even at an altitude of about 600 metres. The aquatic forms are usually green; in swamps and moss bogs it often forms extensive, thick carpets, reddish-brown or almost purple in colour. It is frequently found in fruit.

The leaves are entire or have a few obtuse teeth at the margin, but forms sometimes occur with more deeply toothed leaves or even with the leaf-margin entirely toothed, in the latter case it may be difficult to distinguish the plant from *S. dentata* and from the large aquatic forms of *S. irrigua*. The latter, however, have always cells more thick-walled especially at the angles, while *S. undulata* has always thin-walled leaf-cells.

85. **Scapania curta** (Mart.) Dum.

Common on rocks coated with soil, damp sandy or gravelly ground and on peat, occasionally also on boggy ground up to about 400 metres above sea-level. Near Isafjördur and in Esja it was collected at an

altitude of almost 500 metres. ♂ plants are common, fruit rather rare. The majority of the plants bear gemmæ.

Var. *geniculata* (Mass.) C. M.

S. Iceland: Reykir!; Vestmannaey!. NW. Iceland: Ármuli!.

Var. *rosacea* (Corda) Carr. is only exceptionally met with typically developed, while forms transitional between the present variety and the type are rather common.

The plant is usually green or brownish-green, more rarely reddish. On damp ground it becomes larger and approaches *S. irrigua*. The leaves vary somewhat in form. The antical lobe is usually pointed, in the lower leaves it is, however, often rounded; it is more rare for all the leaves to be rounded. The leaf-cells are as a rule thin-walled or somewhat thickened at the angles. Forms with highly thickened, reddish-brown cell-walls are more rare, and occur always in exposed localities.

86. **Scapania Bartlingii** (Hampe) Nees.

Scapania Carestiae de Not.

S. Iceland: Drángshlid associated with *Amphidium Mougeottii* and *Bryum archangelicum* (H. J.)!.

Note. *Scapania nemorosa* is enumerated in the majority of the older lists, but all the specimens in the collections belong to *Scapania undulata*.

Fam. RADULOIDEÆ.

87. **Radula complanata** Dum. Gottsche.

S. Iceland: Hornafjördur!. E. Iceland: Hof!; Djupivogur!; Seydisfjördur!. N. Iceland: Thrastarholsárgil, fr. (O. D.)!. W. Iceland: Flatey (Grl.)!; Budahraun (H. J.)!. Common in SW. and S. Iceland!.

The plant is common in E., W. and S. Iceland, while it appears to be absent from NW. Iceland and to be rare in N. Iceland.

It occurs only in the lowlands and rarely ascends higher than about 300 metres. In a few localities in Esja and near Kolvidarhol it was collected at an altitude of about 400 metres. It grows especially on dry, or only slightly damp, shaded rock-sides, mostly in clefts and caves, in company with *Metzgeria furcata*, *Lejeunea cavifolia*, etc., and often bears gemmæ and in S. Iceland fruit also. It was sometimes collected on the bark of trees, viz. on birch on Flatey and on mountain ash in Budarhaun.

Fam. MADOTHECOIDEÆ.

88. **Madotheca Cordæana** (Hübener) Dum.

Madotheca rivularis (Dicks.) Nees.

"In Islandia" (Mörch)!. E. Iceland: Hof!; Seydisfjördur (H. J.)!; Berufjördur!. NW. Iceland: Dyrafjördur! at an altitude of about 150 metres;

Dýnjandi!; Grunnavik! at an altitude of about 270 metres. W. Iceland: Nordredalur!; Brynjudalur (Grl.)!; Reykjavik (Grl.; !); several places in Esja!. Common in S. Iceland!. Vestmannaey!

This plant is most widely distributed in S. Iceland where, as on Vestmannaey, it is common on more or less damp rock-sides especially in clefts of the tuff mountains on Fljótshlid and below Eyjafjall. On Vestmannaey it grew sometimes in abundance among fallen stones in Heljusdalur, and sometimes on slopes associated with *Thuidium abietinum* and *Hylocomium* spp. In E. and NW. Iceland it was rarer and generally occurred only sparingly on faces of basalt rocks immediately above the surface of the water of rivers or on damp slopes among stones. This species has not yet been recorded from N. Iceland.

Fam. JUBULEÆ.

89. **Frullania dilatata** Nees.

W. Iceland: Flatey, on mountain ash (name of finder not stated); Dalasýsla, Melar, on sea-fowl cliffs (H. J.)!. Only sterile specimens have been found.

90. **Frullania Tamarisci** Nees.

Common both on dry and on somewhat damp rocks in company with *Hypnaceæ*, *Grimmia* spp., *Antitrichia curtipendula*, etc.; in *Rhacomitrium* heaths (both *R. canescens* and *R. hypnoides*); on slopes among *Hylocomium* spp.; on the top of knolls in marshes, etc.

I do not think the plant occurs at a much higher altitude than about 300 metres and it is always sterile.

91. **Frullania fragilifolia** Tayl.

SW. Iceland: Hafnarfjördur, in a lava cave (Grl.)!; Kolvidarhol!; on a rock-face at an altitude of about 400 metres associated with *Radula* and *Lejeunea*.

92. **Lejeunea cavifolia** (Ehrh.) Lindb.

Lejeunea serpyllifolia (Dicks.) Spr.

"In Islandia" (Mörch)!. W. Iceland: Snæfellsnes!; Sandur in a lava cave (H. J.)!; Hafnarfjördur in lava caves!; Kolvidarhol!. S. Iceland: Seljaland (Stp.)!; common on Fljótshlid and below Eyjafjall!; Thingvallahraun!.

This plant is common in S. Iceland where it grows especially on shady rock-sides in the clefts and caves of tuff mountains, associated with *Metzgeria furcata*, *Madotheca Cordæana*, *Amphidium Mougeotii*, etc. The habitat of greatest altitude is near Kolvidarhol at about 400 metres above sea-level, there it grew on a rock-face associated with *Radula* and *Frullania fragilifolia*.

Besides in the tuff districts, it is also rather frequent in the lava-fields where it grows at the bottom of deep, damp clefts, but as a rule only in small quantities. Sterile specimens only have been found.

Fam. ANTHOCEROTACEÆ.

93. **Anthoceros punctatus** L.

W. Iceland: Reykholtdalur (Ho.; Grl.;!). S. Iceland: Reykirdalur!; Sydri Reykjahver!. This species was first collected by Koenig and figured in Flora Danica, tab. 396.

It occurs near the majority of the hot springs in Reykirdalur. It grows there abundantly on damp clay-flats with a temperature of 20° —30°, associated with *Fossombronia*, *Haplozia crenulata* and *Archidium*, especially on slopes immediately above the hot water. It almost always bears numerous capsules.

II. SPHAGNALES.

1. **Sphagnum imbricatum** (Hornsch.) Russow.

S. Austini Sull.

S. Iceland: Thorlákshver and Laugaráshver near Skálholt!. It grew there on the warm substratum along the outlets from the hot springs in immense yellowish-brown cushions as much as 25 cm. deep.

2. **Sphagnum cymbifolium** (Ehrh.) Hedw.

W. Iceland: near several hot springs in Reykholtdalur!. S. Iceland: Thorlákshver!; sydri Reykjahver!; Laugarvatnshver!; Hurdarbak (H. J.)!.

In all the above localities it grows on damp ground around hot springs.

3. **Sphagnum medium** Limpr.

NW. Iceland: Bæir!; Ármuli!. S. Iceland: Common in the district around Skálholt!. W. Iceland: Reykjavik!

The plant grows everywhere in wet bogs.

4. **Sphagnum papillosum** Lindb.

W. Iceland: Reykjavik!, common on boggy ground; Reykholtdalur (Grl.;!), around numerous hot springs. S. Iceland: Hraun; Grimstadr (H. J.)!; Hraundalshraun (H. J.)!; Sydri Reykjahver!.

In Reykholtdalur *Sphagnum papillosum* constitutes the bulk of the vegetation around the hot springs and, for instance at Deildatunguhver, covers large areas of the warm, damp ground with cushions as much as about 20 cm. deep. It appears to be rather widely distributed in S. Iceland and is found there, as near Reykjavik, on the knolls in the bogs, sometimes on a rather dry substratum.

5. **Sphagnum inundatum** Russow.

W. Iceland: Grundarfjördur (H. J.)!. S. Iceland: Thorlákshver!; Sydri Reykjahver!.

In the two latter localities it grew along the outlets from the hot springs, near Sydri Reykjahver it grew also on the knolls in a small bog near the spring.

6. **Sphagnum Gravetii** Russow.

NW. Iceland: Hesteyri!.

It grew there in pools in company with a very large form of *Hypnum revolvens* v. *Cossoni.*

7. **Sphagnum compactum** De Candolle.

S. rigidum Schimp.

S. Iceland: Nuphlidarháls near Krisuvik (Stp.)!.

8. **Sphagnum teres** (Schimp.) Ångst.

Very common everywhere on damp ground up to a height of about 600 metres above sea-level.

S. teres is the most commonly occurring species of this genus and is almost as frequent in the lowlands as in the Alpine region, at high levels. It grows both on knolls in bogs and on more or less damp slopes and is also common on warm ground.

It is almost always green or pale yellowish-green in colour. Forms with appressed leaves are by far the most frequent; f. *squarrosulum* (Lesq.) is met with here and there, e. g.: Esja, Akureyri, Stadr near Hrutafjördur and Laugaráshver. The walls of the chlorophyll-cells are very often distinctly papillose. Only sterile specimens have been found.

9. **Sphagnum squarrosum** Crome.

N. Iceland: Mývatn (Grl.!); Litlu Borgarkatlar (St.)!; Grimsey (O. D.)!. NW. Iceland: Isafjördur!; Grunnavik!; Sugandafjördur!.

In NW. Iceland it is rather common up to about 300 metres above sea-level. It grows there sometimes on knolls in bogs and sometimes on more dry ground, thus, near Isafjördur it grew in several places on slopes stretching down towards the rivers. Only sterile specimens have been found.

10. **Sphagnum fimbriatum** Wils.

N. Iceland: Akureyri!; Geitaskard!. NW. Iceland: Dýnjandi!; Laugarland!. W. Iceland: Ketilstadr (H. J.)!; Stykkisholmur (H. J.)!; Nordredalur in the district of Borgarfjördur!. S. Iceland: Geldingsey (H. J.)!.

This plant grows usually on very wet ground in bogs and is no doubt commonly distributed in northern and western Iceland. Thus, near Stykkisholm it was common in bogs, and also around Akureyri where it occurred abundantly up to about 400 metres above sea-level.

11. **Sphagnum Girgensohnii** Russow.

E. Iceland: Eskifjördur (H. J.)!; common near Seydisfjördur!. N. Iceland: common near Eyjafjördur (O. D.)!; Geldingafell (St.)!; Hafrardalur

(St.)!. Hvaneyrardalur (St.)!. NW. Iceland: common near Isafjördur!; Dýrafjördur!; Dýnjandi!. W. Iceland: Budir (H. J.)!; Nordredalur in Borgarfjördur!. S. Iceland: Almannagjá!; Laugarvatn!; Ingjaldshóll (H. J.)!; Heidi in Mýrdalur (H. J.)!; Seljaland!.

Commonly distributed both on knolls in bogs and on drier ground. Thus, in lava-clefts near Thingvellir, it is frequently met with on humus-covered blocks associated with *Rhacomitrium hypnoides* and *Hylocomium* spp. It is of most frequent occurrence in the lower country, but near Eyjafjördur it ascends to about 600 metres and near Isafjördur to about 400 metres above sea-level. Fruit was found in several places. It occurs especially in orthocladous forms.

12. **Sphagnum Russowii** Warnst.

S. Iceland: Thingvellir!.

13. **Sphagnum Warnstorfii** Russow.

Common on knolls in bogs and on damp ground on slopes up to a height of about 500 metres.

Reddish forms are of most frequent occurrence, violet, green and yellowish-green forms are far more rarely met with. Only sterile specimens have been found.

14. **Sphagnum rubellum** Wils.

Common on knolls in bogs and on wet slopes especially in the lowlands, but it also frequently ascends to about 500 metres above sea-level. Red and violet forms are frequent, green ones are rarer. Only sterile specimens have been found.

15. **Sphagnum acutifolium** Ehrh.

"In Islandia leg. Mörch"!. N. Iceland: Hof (O. D.)!. NW. Iceland: Isafjördur!; Ármuli!. W. Iceland: Reykholtdalur on warm ground (Grl.;! ; Reykjavik!; between Thingvellir and Geysir (Grl.!).

Occurs here and there on boggy ground in the lowlands and as a rule rather sparingly. Near Isafjördur it was found in a bog at an altitude of 250 metres. Only sterile specimens have been found.

16. **Sphagnum subnitens** Russ. et Warnst.

NW. Iceland: Bæir!; Thorvaldsdalur (St.)!. W. Iceland: Grund!; Snældubeinstadahver in Reykholtdalur!; Reykjavik (H. J.;!). S. Iceland: Laugaráshver!; Borg (H. J.)!; Krisuvik (Stp.)!.

Found here and there in NW., W. and S. Iceland where it occurs both in bogs and along the margin of hot springs. It is frequent around Reykjavik where it was also gathered in fruit. It is as a rule pale yellowish-green in colour. Near Laugaráshver a f. *violascens* was found growing in large cushions on warm ground.

17. **Sphagnum Lindbergii** Sch.

W. Iceland: Ketilstadr among *S. fimbriatum* (H. J.)!.

18. **Sphagnum riparium** Ångst.

NW. Iceland: Thoroddstadaengjar (St.)!; common in pools and in very wet parts of bogs near Jökulsfjördur!.

19. **Sphagnum angustifolium** C. Jens.

N. Iceland: Akureyri!. W. Iceland: Reykholtdalur near a number of hot springs!. S. Iceland: Reykirdalur!; Laugaráshver!.

This species occurs abundantly along outlets from the hot springs in deep cushions of a pale green, yellowish or light brownish-yellow colour. The leaves are distinctly wavy in all the plants from a warm substratum. Its occurrence at Akureyri is peculiar; there it grew at an altitude of about 500—600 metres on wet boggy ground as a slender, pale-green, but otherwise typical, form. Only sterile specimens have been found.

20. **Sphagnum Dusenii** C. Jens.

W. Iceland: Snældubeinstadahver in Reykholtdalur!.

In the above locality it grew in large yellowish-brown tufts in warm water of a temperature of 25°, near a hot spring.

MUSCI VERI

Fam. ANDREÆACEÆ.

1. **Andreæa petrophila** Ehrh.

Very common all over Iceland. In the lowlands it grows in small round cushions on blocks and on rocks in dry situations and in such localities it is often the dominant species. On mountain heights, where it is frequently met with right at the upper limit of vegetation, it often descends upon the ground, even upon damp gravelly flats, where it forms extensive cushions almost black in colour. Fruit is almost always present.

Note. *Andreæa rupestris* L. = A. *Rothii* W. M. is recorded by Mörch from Iceland and is figured in Flora Danica, tab. 2125, but Mörch's specimens must be referred to *A. petrophila*.

Fam. ARCHIDIACEÆ.

2. **Archidium phascoides** Bridel.

W. Iceland: Reykholtdalur!, near all the hot springs (Grl.;!); Englandshver!. S. Iceland: Reykirdalur!; Reykjanes (Ostf. !; Kolvidarhol!; Thorlákshver!; Laugaráshver!; Sydri Reykjahver!; Geysir!.

Archidium phascoides occurs in the collections under different names. It was first collected by Grönlund and determined by Zetterstedt as *Leskea nervosa*. Afterwards this specimen with several others were re-determined by Grönlund as *Catoscopium nigritum* var. *Grönlundii* established by C. Jensen. All the plants collected by Ostenfeld from Reykjanes are determined by C. Jensen as *Pohlia nutans* v. *filicaulis*. The reason for all these erroneous determinations will be found in the fact that the plant is almost always found barren and in leaf-form and cell-tissue presents a certain resemblance to mosses belonging to quite different groups, which often leads to the belief that the specimens in question are stunted forms or have been affected by the warm substratum: thus, certain forms bear a striking likeness to a slender *Amblystegium compactum*. The plant is typical of warm clay flats, and in S. and W. Iceland it is met with around every hot spring. On the warm clay flats with a temperature of 20°—40°, it forms extensive yellowish-green mats 1—2 cm. high. On slopes stretching down towards the boiling water and along outlets from the springs it is also frequently found growing within a few centimetres from the water, usually mixed

with *Haplozia crenulata* and *Fossombronia Dumortieri*, more rarely with *Gymnocolea inflata*. It is almost always sterile; on plants from Thorlákshver flowers as well as a few ripe capsules were found, besides, here and there at the bottom of the tufts, the characteristic large spores (9. 6. 1912).

Note. *Phascum cuspidatum*, *Ephemerum serratum* and *Sphærangium muticum* are enumerated on older lists, but no specimens of these species are to be found in the collections and their occurrence in Iceland is very improbable.

Fam. WEISIACEÆ.

3. **Gymnostomum rupestre** Schleich.

E. Iceland: Geithellir!. N. Iceland: Akureyri!; Mödruvellir; Hof (O. D.)!. W. Iceland: Brynjudalur (Grl.)!; Esja!. S. Iceland: Skálholt!; Thingvellir!.

Around Eyjafjördur it is common on damp rocks up to a height of about 300 metres; it was also found in numerous localities in SW. and S. Iceland and is common, for instance in Esja. It occurs especially on damp rock-sides near waterfalls and in clefts, often forming extensive mats; now and then it is also found in dry localities. Only sterile specimens have been found.

4. **Hymenostylium curvirostre** (Ehrh.) Lindb.

Barbula curvirostris Lindb.

N. Iceland: Mývatn (Grl.)!. W. Iceland: Reykholt (Grl.)!, in both localities sparingly and also sterile. S. Iceland: Merkjáfoss (F.)!; Barkarstadr, fr.!; Holt, fr.!; Vestmannaey, fr.!.

In S. Iceland the plant is no doubt common on faces of damp tuff-rocks. In several localities near Barkarstadr and Holt it occurred abundantly in clefts along rivers or in caves and in depressions in tuff rocks; it was usually richly in fruit, and associated with *Preissia commutata*, *Fegatella*, *Haplozia riparia*, etc. On "Kleven" on the island of Vestmannaey it grew on the face of a tuff rock, through which water was percolating, forming with *Haplozia riparia* large cushions which were saturated with water.

5. **Anoectangium compactum** Schwgr.

Pleurozygodon æstivus (Hedw.) Lindb.

"In Islandia" leg. Mörch! and figured in Flora Danica, tab. 1893, fig. 2, under the name of *Gymnostomum curvirostre*.

E. Iceland: Seydisfjördur, common!; Berufjördur, common!. W. Iceland: Grundarfjördur (H. J.)!; Hafnarfjördur (Grl.)!; Esja!; Svinahraun!. S. Iceland: very common!; Vestmannaey!.

This plant is very common in S., SW. and E. Iceland, but it does not appear to occur in N. and NW. Iceland. It grows especially on damp

rocks, e. g. on rock-sides along waterfalls and in clefts, where it forms large cushions, often almost one square metre in size, of a peculiar verdigris colour. In the lava-fields of SW. Iceland it is one of the most frequent species on the walls of caves and the sides of clefts. It hardly ascends higher than about 300 metres above sea-level. It is almost always sterile. The only fruiting specimen was collected by Mörch, but no habitat is given.

6. **Weisia crispata** (Br. germ.) Jur.

SW. Iceland: Reykjavik, fr.!. SE. Iceland: Hornafjördur!; SW. Iceland: Álafoss!.

Near Reykjavik it grew in crevices of basalt rocks associated with *Encalypta rhabdocarpa* and *Bryum elegans* var. *carinthiacum*. The fruit had just ripened on June 6, 1909. Near Hornafjördur also it grew in small crevices of basalt. Only sterile specimens have been found.

7. **Weisia viridula** (L.) Hedw.

S. Iceland: Vik, associated with *Brachythecium velutinum* (H. J.)!. Vestmannaey, Helgafell!, on a humus-covered block of lava.

Only sterile specimens have been found.

The species is recorded by Mörch from Iceland, but no specimens of it are to be found in the collections.

8. **Weisia Wimmeriana** (Sendtn.) Br. eur.

N. Iceland: Hof near Eyjafjördur (O. D.)!, fr.

It grew there mixed with *Eurynchium diversifolium* on rocks coated with soil.

9. **Dicranoweisia crispula** (Hedw.) Lindb.

Very common all over Iceland.

Dicranoweisia crispula is one of those species which is of equal frequency in all parts of Iceland, both at the coasts and in the highlands, and at all altitudes up to the snow-line. In the low land it grows, like *Andreæa*, on dry stones and rocks, but like the latter, it descends to the ground on mountain heights where it forms, both on the ground or on blocks of rock, dense, jet-black cushions. It is almost always found in fruit.

Note. *Dicranoweisia cirrata* is recorded by Hornemann, but has undoubtedly been confused with *D. crispula*.

10. **Dicranoweisia compacta** (Schleich.) Schimp.

N. Iceland: Hof near Eyjafjördur (O. D.)!. Only sterile specimens have been found.

Fam. RHABDOWEISIACEÆ.

11. **Cynodontium polycarpum** (Ehr.) Schimp.

Seydisfjördur (C. Hansen)!.

This species together with the var. *strumiferum*, is recorded by Vahl, but has without doubt been confused with another species, probably a *Dicranum* or *Oncophorus*. Mörch also records both forms from Iceland, but of his specimens in the Botanical Museum in Copenhagen some are *Dicranum Starckei*, and some are *Ceratodon purpureus*.

Cynodontium gracilescens var. *tenellum* is recorded by Carrington from Akureyri, but has undoubtedly been confused with another species.

12. **Dichodontium pellucidum** (L.) Schimp.

Very common everywhere on damp ground.

This plant is most widely distributed in the lowlands and is found there everywhere on damp ground, both in bogs and on gravelly soil along streams, and also on soil-covered rocks. In the lowlands it usually grows mixed with all kinds of other mosses in their tufts and is, as a rule, low in growth and short-leaved. On rocks near the water, where it is also frequent, more vigorous forms occur in unmixed tufts, 2—4 cm. high. At higher levels it occurs more sparingly, but is nevertheless frequently found up to about 600 metres above sea-level. Only sterile specimens have been found.

Fam. AONGSTRŒMIACEÆ.

13. **Aongstrœmia longipes** (Sommerf.) Br. eur.

E. Iceland: Hornafjördur!; Hof!; Seydisfjördur!; Vallanes!. N. Iceland: Akureyri (O. D.;!); Husavik!; Vidimyri!; the Tverá!; Dettifoss!; Stadr near Hrutafjördur!. NW. Iceland: Ármuli!. W. Iceland: Haukadal!; Lundur!; Álafoss!. S. Iceland: Breidabolstadr!; Barkarstadr!; Seljaland!.

This species is doubtless common everywhere, but is often overlooked on account of its minute size. It grows on damp ground, most frequently as single specimens scattered among other mosses; more rarely, as for instance near Hornafjördur and Breidabolstadr, abundantly on peat along ditches. Near Lundur it grew abundantly associated with *Dicranella Schreberi*, *Bryum lacustre*, *Dichodontium* and other species in places where the peat had been pared off.

In the majority of the cases the specimens were not found until the material brought home had been investigated, because in habit they exactly resemble the tiny *Pohlia*-forms of wide occurrence, or a small, sterile *Anomobryum*.

On boggy ground it was usually collected together with *Dichodontium pellucidum*, *Oncophorus Wahlenbergii*, *Meesia trichoides*, *Bryum* spp., etc. On gravelly soil near Stadr it was found associated with *Dicranella crispa*, *Didymodon rubellus*, *Blasia pusilla* and *Haplozia atrovirens* and in several places with *Distichium inclinatum*. It occurs both in the low-

lands and up to 500—600 metres above sea-level. Near Akureyri it was found on a damp flat at about 500 metres. Near Barkarstadr it occurred abundantly on boggy ground at about 530 metres, and near Seljaland it was also frequent at an altitude of about 500 metres on a moss-grown gravelly flat. Only sterile specimens have been found.

Fam. DICRANACEÆ.

14. **Oncophorus virens** (Sw.) Brid.

Very common on damp ground. It grows both on wet humus-covered rocks and in bogs, and also on damp gravelly ground, sometimes as unmixed tufts and sometimes mixed with other mosses; it is of equal frequency at all altitudes as far upwards as 600—700 metres. It often occurs in great quantities and usually fruits richly. In the lower districts the fruit ripens about July 1st. In S. Iceland this species is either wanting or rare in the lowlands up to a height of about 300 metres (it has not been found on Vestmannaey), but from this height up to the snow-line it occurs abundantly in bogs.
Var. *serratus* Br. eur. occurs occasionally on wet rocks.

15. **Oncophorus Wahlenbergii** Brid.

One of the most commonly occurring mosses; it is found everywhere in damp localities just like *O. virens*. It is very common especially in bogs, except in S. Iceland where, like *O. virens*, it has its distribution from an altitude of 300 metres upwards.
Var. *β compactus* (Funch) Br. eur. E. Iceland: Skreiddal!; Seydisfjördur!. It grew in both localities on knolls in bogs.
Var. *elongatum* Hagen. W. Iceland: Nordredalur!. It grew there on boggy ground in association with *Sphagnum teres*, *S. rubellum* and *S. fimbriatum* in loose tufts about 6 cm. high.

Although typically developed forms of *Oncophorus Wahlenbergii* and *O. virens* differ so widely from each other that they are not likely to be confused, yet so many transitional forms occur, especially in Alpine habitats, that very often it is a matter of opinion to which species such a form should be referred. On the same plant leaves may be found which, as regards the cells of the leaf-base, resemble sometimes *O. Wahlenbergii* and sometimes *O. virens*; also the leaf-margin is more or less recurved or plane.

16. **Dicranella squarrosa** (Starke) Schimp.

E. Iceland: Seydisfjördur!; Skorastadr (H. J.)!. N. Iceland: Husavik!; near Eyjafjördur (O. D.;!), fr.; Lækjarmot!. NW. Iceland: Very common!. W. Iceland: Vogur (H. J.)!; Esja!; Reykholtdalur!. S. Iceland: Holt!.

This plant grows almost always in water, especially on inundated gravelly ground by streams, on stones and in moss bogs, more rarely on wet marshy ground. In NW. Iceland it is one of the mosses of most frequent occurrence being found in abundance associated with

Philonotis seriata, *Oncophorus Wahlenbergii*, *Scapania uliginosa*, *Haplozia cordifolia* and *Chiloscyphus polyanthus* var. *fragilis* on inundated gravelly ground up to about 300—400 metres above sea-level. In N. Iceland it is also rather common. Near Seydisfjördur it was found only at a height of about 300 to 500 metres above sea-level, but was common there in small streams associated with *Scapania undulata*, *Hypnum exannulatum*, *Haplozia cordifolia*, etc. In Reykholtdalur this species was found in several places near hot springs, even on stones in warm water with a temperature of 30°. In SW. and S. Iceland it occurs rarely and more sparingly; near Holt it grew in several places at an altitude of 150—600 metres.

The plant is almost always found sterile. One specimen collected by O. D. near Hof in Eyjafjördur 12. 6. 1897) bore a few capsules which had thrown off their lids. The ♂ plant was found only near Bæir in NW. Iceland growing in low tufts, about 1 cm. high.

17. **Dicranella Schreberi** (Sw.) Schimp.

Anisothecium crispum (Schreb.) Lindb.

N. Iceland: Hof near Eyjafjördur (O. D.)!; Akureyri ♀!. W. Iceland: Lundur!.

Near Akureyri it grew in damp, peaty ground immediately north of the town and near Lundur, associated with *Bryum lacustre*, *Aongstræmia longipes* and *Dichodontium pellucidum*, on a wet flat from which the peat had been pared off.

18. **Dicranella crispa** (Ehrh.) Schimp.

Very common on damp ground, both on peat and on sandy or gravelly soil by streams. It occurs only in the lowlands, and has hardly been found higher than at an altitude of about 200 metres. Fruit is always present in abundance and ripens about August 1st. At this time also the setæ of the capsules of the ensuing year have reached their full length.

Note. *Dicranella heteromalla* is recorded by Zoëga and Hornemann from Iceland, but was undoubtedly confused with another species.

19. **Dicranella subulata** (Hedw.) Schimp.

Dicranella secunda (Sw.) Lindb.

Iceland (Mörch)!, some of the specimens are correctly determined, some must be referred to *Ditrichum homomallum*. Krisuvik (Stp.)!. N. Iceland: Husavik!. NW. Iceland: Kaldalon!; Gnupsdalur near Dýrafjördur!. Moreover, Grönlund records it from Hvammur and Thingvellir, but both specimens are wrongly determined, being *Dicranella crispa* and *Dicranum Blyttii*.

This species was collected in small quantities only, but everywhere in fruit. Near Husavik it grew on peat, and on July 11, 1909 it bore

both quite young capsules and also old lidless capsules. In Gnupsdalur it grew along the banks of streams with *Scapania subalpina* and *Cephalozia bicuspidata*.

20. **Dicranella cerviculata** (Hedw.) Schimp.

Iceland: (Mörch)!. NW. Iceland: Stadr on Snæfjallaströnd (Stp.)!; Dýnjandi!. W. Iceland: Borgarnes!; Kollafjördur!; Reykjavik (Grl.;!). S. Iceland: Thjorsá (Stp.)!.

The plant was found everywhere in fruit. Near Borgarnes and Reykjavik the fruit was almost ripe at the beginning of August. It grows on peat, especially on the rather dry margins of turf pits and ditches and occurred abundantly especially in several places near Reykjavik.

21. **Dicranum fulvellum** (Dicks.) Sm.

Collected in Iceland by Mörch (no doubt near Middalur) and figured in Flora Danica, tab. 2002, under the name of *D. Mörchianum* Hornsch. S. Iceland: Holt!; Seljaland!; Thingvallahraun!. SW. Iceland: Svinahraun!.

This species is recorded by Grönlund from Svinaskard and Thingvalla, but the specimens from both localities are wrongly determined, being really *D. falcatum* and *D. Blyttii* respectively.

Dicranum fulvellum has been only found in the south-western part of Iceland, where it appears to be frequent. In Svinahraun, where the altitude hardly exceeds 300 metres, it was found rather sparingly (June 3rd) on the top of lava-blocks, in fruit which was almost ripe. On Eyjafjall it occurred in several localities above Holt and Seljaland at an altitude of 300—700 metres. It grew either on blocks of basalt or more rarely on gravelly ground in company with *Gymnomitrium concinnatum*. At the end of July the fruit was ripe everywhere, and generally the capsules had thrown off their lids.

22. **Dicranum Andersonii** (Wich.) Schimp.

SE. Iceland: Hof!; coastal cliffs near Alftafjördur!. S. Iceland: Holt!; Vestmannaey!; Thingvellir!.

Near Hof it occurred rather commonly on low basalt ridges, where it usually grew in crevices in small cushions about 3 cm. high. Here the fruit had just ripened on June 15th and the lids still persisted. Near Holt it was found rather frequently on tuff rocks up to a height of about 300 metres. Thus, it grew abundantly, for instance on the vertical northern face of a tuff rock sometimes in small tufts, sometimes mixed with *Grimmia apocarpa*, *Pogonatum urnigerum*, *Pohlia grandiflora*, *Anthelia nivalis* and *Gymnomitrium concinnatum*. On Vestmannaey the plant grew abundantly on blocks of lava lying on the slope of Helgafell. It occurred there everywhere in small scattered tufts associated with *Grimmia apocarpa*, *Rhacomitrium sudeticum*, *R. fasciculare* and *Andreæa petrophila*. The fruit was ripe on July 5th; a few had thrown off their lids.

In Iceland *Dicranum Andersonii* is a decidedly lowland plant, which is probably widely distributed in the southern and south-eastern parts of the country. It occurs especially near the coast; in the interior of the country it has been found only near Thingvellir, where it grew very sparingly on a lava block in company with *D. fulvellum*, which it resembles in the fact that the peristome teeth are wide-spreading when dry. *Dicranum Andersonii* is however easily distinguished by its shorter seta and by the extremely thick-walled cells of the capsule-walls and by the absence of stomata.

23. **Dicranum falcatum** Hedw.

E. Iceland: Lonsheidi!, at an altitude of about 400 metres; Berufjördur!. N. Iceland: Ljosavatnsberg!. NW. Iceland: Dýrafjördur!; Isafjördur!. W. Iceland: Snæfellsnes: Saxarhol (H. J.)!; Frodarheidi (H. J.)!; Reynivellir (Grl.)!; Svinaskard (Grl.)!; Kolvidarhol!; Esja!. S. Iceland: Holt!; Seljaland!. The plant is recorded by Mörch from Iceland and figured in Flora Danica, tab. 2003, but Mörch's specimens in the Botanical Museum in Copenhagen belong to *Dicranoweisia crispula*.

Dicranum falcatum is a plant characteristic of the damp gravelly flats of mountain heights, where it often occurs abundantly in large, compact, rounded cushions in the neighbourhood of patches of snow. Usually it is not met with until an altitude of about 600 metres; near Kolvidarhol, however, it was common even at an altitude of about 400 metres. This species is very common in NW. and in S. Iceland and occurred also abundantly on Ljosavatnsberg. It is probably common everywhere on mountain heights, but, as for instance in E. Iceland, it has only been collected scantily, as its habitats are snow-covered in June when that part was explored.

The fruit, which is always present abundantly, ripens about the middle of July.

24. **Dicranum Blyttii** Schimp.

Dicranum Schisti (Gunn.) Lindb.

E. Iceland: Hamarfjördur!. N. Iceland: Reykjaheide!; Vidvik (P. S.)!; Hof (O. D.)!. NW. Iceland: Patreksfjördur (Wiinstedt)!; Gláma (St.)!, common on mountain heights!. W. Iceland: Øxarrhyggur!; Svinahraun!; Hafnarfjördur!. S. Iceland: Seljaland!, from an altitude of 350 metres upwards; Holt!, common on mountain heights; Thingvallahraun!.

This species is common, at any rate in NW. and SW. Iceland, while it has been found but scantily in E. Iceland and only in a few localities in N. Iceland. But the same is probably the case here as mentioned for *Dicranum falcatum*, that its habitats, at the time when E. Iceland was explored (June 1909), were covered with snow.

Dicranum Blyttii belongs to the Alpine region and is not met with until an altitude of 300–400 metres. Near Hamarfjördur, however, it grew in the lowlands on rocks near the coast. It grows partly on stones and partly on gravel, and is especially frequent at a height of 600—800 metres, both on gravelly flats soaked by the melting snow,

and on scattered blocks of rock. It often forms there extensive, blackish-green or almost black cushions, 2—3 cm. deep.

In lava-fields it occurs associated with several other Alpine species at the bottom of ravines, as on Reykjaheide (at an altitude of about 300 metres), in Thingvallahraun, where it was rather common on fallen blocks in ravines (Gjá), and near Hafnarfjördur, where it was also rather frequent in lava-clefts. In Svinahraun it grew abundantly on damp ground in a large depression at the edge of the lava-field.

The leaves usually spread erectly, more rarely, for instance in plants from Thingvellir, they are secund. The fruit ripens almost at the same time on mountain heights and in the lava-fields, viz. at the end of July. Near Thingvellir it was found on July 29th with fully ripe capsules, some of which had thrown off their lids.

25. **Dicranum Starckei** Web. et Mohr.

"In Islandia" (determined by Mörch as *Dicranum polycarpon*).

Widely distributed all over Iceland.

This species is most widely distributed on damp gravelly flats from an altitude of about 400 metres upwards to the snow-line and is often there, especially from about 400—600 metres, the most abundant constituent of the vegetation, growing in extensive, continuous mats, 2—3 cm. deep. It occurs however also on stones and damp rocks. It is found more scantily in the more low-lying parts of the country, although, especially in NW. and N. Iceland, it is frequent, mixed with other mosses, on gravelly ground by streams. In the southern part of the country it does not appear to descend to a lower level than 300—400 metres.

Like *Dicranum Blyttii* this species grows also in lava-clefts, and it was common on fallen blocks both near Hafnarfjördur and Thingvellir. The plants from these localities were often 5—6 cm. high, with longer leaves, in which feature they approached very closely to *D. molle*.

The direction of the leaves varies considerably, orthophyllous forms are the most frequent, especially on the ground; highly drepanophyllous forms occur more particularly in drier localities, for instance on rocks.

Fruit is almost always present. The majority of the specimens collected (June—July) had old, empty capsules, and also young green ones or half-ripe ones which probably ripen late in the summer.

26. **Dicranum molle** Wils.

D. arcticum Schimp. *D. glaciale* Berggr.

E. Iceland: Seydisfjördur!, at an altitude of about 200 metres. N. Iceland: Akureyri!. NW. Iceland: Dýrafjördur!; Sugandafjördur!; Isafjördur!; Kaldalon!; Dýnjandi!. W. Iceland: Snæfellsnes, Mafahlid (H. J.)!, at an altitude of about 300 metres; Budahraun (H. J.)!; Dalasysla, Vighólsstadir (H. J.)!, 550 metres alt.; Olafsvig (Mörch)!; Svinaskard (F.)!; Esja, Mödruvellir!, at an altitude of about 450 metres; Hafnarfjördur!. S. Iceland: Thingvallahraun!.

This species is also recorded from several localities by Grönlund,

but the specimens in the Botanical Museum are wrongly determined: most af them must be referred to *D. Starckei* or *D. angustum.*

Dicranum molle usually grows on damp gravelly ground on mountain heights. In NW. Iceland it is one of the most commonly occurring mosses on rocky flats, and is common down to about 200 metres above sea-level; but also frequently descends as far down as the bottom of the valley. It grows both on gravelly flats soaked by melting snow and on damp slopes; also on lower levels on heathy soil, with other *Dicranum* spp. *(D. scoparium* and *D. fuscescens)*, among *Vaccinium, Empetrum*, etc., in large tufts which are usually closely interwoven with *Lophozia lycopodioides*, *L. Kunzeana*, *L. quinquedentata*, *L. Floerckei*, *L. ventricosa* and other Hepaticæ. Near Mödruvellir it grew partly on damp gravelly ground, partly intermixed in abundance in *Rhacomitrium hypnoides*-heaths; in this latter locality also it was mixed with *Lophozia* spp.

In lava-fields it usually grows in company with *D. Starckei*, commonly, as for instance in the clefts near Thingvellir, in cushions as much as 10 cm. deep. The plants from the latter locality and from Hafnarfjördurhraun are sometimes not quite typical and approach so closely to *D. Starckei*, that they can hardly be distinguished. The leaves are sometimes orthophyllous, sometimes drepanophyllous. The fruit, which is always present abundantly, ripens during July. In the district of Isafjördur, however, ripe fruit was frequently found as early as in the latter days of June.

27. **Dicranum Bonjeani** de Not.

D. palustre Br. eur.

SE. Iceland: Hornafjördur!; Lon!. N. Iceland: near Eyjafjördur (O. D.)!. W. Iceland: Dalasysla: Ketilstadr (H. J.)!; Reykholtdalur (Grl.!; Reykjavik!.

The plants from all the above-mentioned localities agree exactly with *D. Bonjeani*, but being quite sterile they cannot be determined with perfect certainty. Bog-forms of *Dicranum scoparium* have often erect leaves, slightly undulate at the apex, and are then extremely difficult to distinguish from *D. Bonjeani*. This species grows in bogs, usually on knolls, and is common around Reykjavik and near Hornafjördur.

Note. In several older lists *Dicranum undulatum* is enumerated as found in Iceland by Mörch and is also recorded by Grönlund from Reykholt and Reykjavik, but all the specimens in the herbaria must either be referred to *D. scoparum* or *D. palustre.*

28. **Dicranum angustum** Lindb.

E. Iceland: Hornafjördur!; Berufjördur!; Lon!; Hof!. N. Iceland: Mývatn (Grl.; determined as *D. arcticum*)!; Stadr near Hrutafjördur!. NW. Iceland: Dýnjandi!. W. Iceland: Stykkisholmur!; Reykjavik!. S. Iceland: Asolfskálaheidi near Holt!, at an altitude of about 400 metres.

This species is no doubt widely distributed over the whole of Iceland; it is, at any rate, rather common in E. and SW. Iceland, where

it often occurs abundantly. It grows on wet boggy ground in loose tufts as much as 6 cm. high, either pure or mixed with *Sphagna* and *Hypnum stramineum* and interwoven with Hepaticæ such as *Lophozia quinquedentata, Scapania irrigua, Cephalozia pleniceps*, etc. Only sterile specimens have been found.

This species is most widely distributed in the lowlands and has only once been collected at an altitude of 400 metres on Asolfskálaheidi, where it grew plentifully in a bog.

Hagen (Musci Norv. Borealis, p. 22) states that *D. angustum* differs from all nearly allied species, and especially from *D. scoparium*, in having thin-walled cortical cells; but this distinction does not suffice as regards bog-forms of *D. scoparium* as in the latter species all transitional stages are found from the thin-walled, hyaline cortical cells of plants from wet ground to the thick-walled, brown cells of xerophilous forms.

29. **Dicranum majus** Smith.

NW. Iceland: Dýrafjördur!; Sugandafjördur!; Isafjördur!. W. Iceland: Neshraun (H. J.)!; Budahraun (H. J.)!.

In the two habitats in W. Iceland, both of them on Snæfellsnes, the plants were collected in depressions in the lava-field. In NW. Iceland, where it is commonly distributed, it grows on the ground on slopes covered with birch coppice, *Vaccinium*, etc., as far upwards as about 300 metres above sea-level.

The majority of the plants collected have slightly secund leaves and entirely resemble *D. scoparium* in habit. A vigorous form with strongly falcate leaves was found in a birch coppice near Dýrafjördur at an altitude of about 150 metres. Only sterile specimens have been found.

30. **Dicranum scoparium** (L.) Hedw.

Very common.

D. scoparium is most widely distributed in the more low-lying parts of the country up to a height of about 400—500 metres, but also ascends frequently to about 700 metres above sea-level. In S. Iceland it appears to be more rare and, as for instance on Fljótshlid and south of Eyjafjall, was only found in a few localities and very scantily. It grows both on rather dry and on damp ground, and also on rocks and on knolls in bogs, and varies considerably. Orthophyllous forms are the most common, especially on damp ground, while more or less distinctly drepanophyllous forms grow by preference in dry localities, for instance in lava-fields and on rocks. In bog-forms the leaves are slightly undulate at the apex, in which feature it approaches *D. Bonjeani*. The leaf-apex, especially in orthophyllous forms, is usually short and broad, and faintly toothed, or even quite entire, at the margin, at the same time the lamellæ on the back of the leaves develop more slightly or disappear almost entirely. Such forms agree well with var. *integrifolium* Lindb.

Fruit is found rather rarely; in Nordredalur it was fully developed on August 2nd, but was still green.

31. **Dicranum fuscescens** Turn.

Iceland (Wiinstedt, determined by Berggren as *D. Scottianum*). NW. Iceland: very common!. W. Iceland: Nordredalur!.

In NW. Iceland *D. fuscescens* is the most frequently occurring species of this genus and is very common from the bottom of the valley up to a height of 400—500 metres. It is most widely distributed from about 100 to 300 metres on somewhat damp slopes covered with *Vaccinium-Empetrum* heath, where it often constitutes the bulk of the Bryophyte vegetation in association with *D. molle*, *D. scoparium* and occasionally, *D. majus*. It is also common on the top of knolls in bogs. The densely matted tufts, which are as much as 10 cm. high, are almost always interwoven with Hepaticæ, especially *Lophozia* spp., *Cephalozia pleniceps, C. bicuspidata* and *Ptilidium ciliare*. In Nordredal it was growing in birch coppices in company with *Hylocomium* spp.

The fruit, which occurs rather frequently, was quite green even in the beginning of July.

All the Iceland specimens differ from the typical form and, more or less, especially approach *Dicranum congestum* without, however, forming any real transitional form to the latter. As a rule the leaf-nerve occupies about $1/4$ the width of the leaf-base, but occasionally $1/5$—$1/6$ only. The cells of the leaf-apex are usually quadrate or roundish, mixed with numerous ones that are irregular in form; rarely, in the main, shortly rectangular, in which feature it approaches var. *angustifolium* Arn. et Jensen; most frequently arranged more or less distinctly in rows; papillose at back, more rarely almost smooth, but in the same tuft or even on the same stem rather considerable variations occur as regards the development of the cell-tissue and the papillæ of the leaves.

32. **Dicranum congestum** Brid.

Very common in E. and N. Iceland and probably also in W. Iceland, somewhat rarer in S. Iceland. It appears to be quite absent from NW. Iceland and to be replaced there by *D. fuscescens*.

It grows both on a dry and on a somewhat damp substratum, on earth and humus-covered stony slopes and on the top of knolls in bogs, and extends as far upwards as to the snow-line, for instance near Akureyri up to about 900 metres above sea-level. In S. Iceland it has not been found in the low land, but plentifully in several places on the rocky flat, for instance near Barkastadr, 500 metres above sea-level.

Var. ***subspadiceum*** Arn. et Jensen occasionally occurs in localities similar to those of the type, but transitional forms are of more frequent occurrence.

Var. ***flexicaule*** (Brid.) Br. eur. N. Iceland: Ljosavatn!, in *Betula-nana* heath; Hof (O. D.)!.

Only sterile specimens have been found.

Dicranum congestum is so variable a species that it is hardly possible to find two plants which are exactly alike. The nerve occupies $1/6$—$1/10$ the width of the leaf at its base, usually $1/8$—$1/9$. The leaf-cells

are irregular in form more or less far down the leaf, sometimes far below the middle, sometimes only at the leaf-apex itself; slightly or hardly porose, occasionally strongly porose in the lower half of the leaf, more rarely to near the apex, in the last case the walls are strongly incrassate.

Dicranum brevifolium Lindb. is recorded from Vatnsdalsfjall (Grl., Tillæg til Islands Kryptogamflora, Bot. Tids., 20), but the plant from the latter locality is only a form of *D. congestum* in which the irregularly shaped cells are strongly incrassate and extend down below the middle of the leaf. Such forms, which, as a rule, are also distinguished by very strong nerves, have been found in several localities, for instance near Berufjördur and about Eyjafjördur. The true *D. brevifolium*, which is distinguished by its shorter leaves, crisped when dry, and its thin-walled cells, which are in a great measure quadrate and in rows, has not been found in Iceland.

33. **Dicranum spadiceum** Zett.

W. Iceland: Hvitidalur (H. J.)!. E. Iceland: Hornafjördur!; Seydisfjördur!. N. Iceland: Hof (O. D.)!; Vatnsdalsfjall (St.)!.

Grows on a damp substratum, especially on knolls in bogs. Only sterile specimens have been found.

34. **Dicranum elongatum** Schleich.

"In Islandia" Mörch! (fr.). N. Iceland: By Hrutafjördur!. NW. Iceland: Dýnjandi!; Hesteyri!. W. Iceland: Stykkisholmur!. This species is also recorded from some localities by Grönlund, but the specimens in the collections are wrongly determined, being *D. Starckei*, and others.

D. elongatum grows everywhere on wet, boggy ground. By Hrutafjördur it was common on knolls in bogs along the eastern side of the fjord from Stadrbakki to Stadr, and it was also frequent in bogs near Stykkisholmur.

All the specimens collected were quite typical. The nerve was about $^1/_4$ the width of the leaf at its base. With the exception of the specimen found by Mörch only sterile specimens have been collected.

Note. According to Gliemann, *Dicranum montanum* was found in Iceland by Mörch, but no specimens of it are to be found in the collections, and the record of this species is undoubtedly due to an erroneous determination.

35. **Campylopus Schimperi** Milde.

N. Iceland: Geitaskard!. E. Iceland: Hornafjördur!; Lon!; Berufjördur!. W. Iceland: Reykjavik!; Esja (Grl.)!. S. Iceland: Breidabolstadr!.

Commonly distributed in South-western and South-eastern Iceland on damp ground in bogs, where it forms compact cushions, 2—3 cm. deep. It has only been found in the low land.

36. **Campylopus flexuosus** (L.) Brid.

N. Iceland: Mývatn (Grl.)!; Reykir near Svinavatn (Grl.)!. W. Iceland: Near hot springs in Reykholtdalur: Deildatunguhver (Grl.)! ; Skribla (Grl.)!; Hagindishver!, etc.

This species has been found only on steaming clayey flats near hot springs in North and West Iceland. In Reykholtdalur it is frequent on a warm substratum, and was found, for instance near Deildatunguhver, in large mats, about 2 cm. deep, on warm clayey flats with a temperature of about 40° just below the surface.

37. **Campylopus fragilis** (Dicks.) Br. eur.

S. Iceland: Laugaráshver near Skálholt.

It grew there on warm clayey flats close to the outlet from the spring.

38. **Trematodon ambiguus** (Hedw.) Hornsch.

W. Iceland: near Borgarnes!.

It grew there rather scantily on damp peaty soil by the road, in company with *Bryum inclinatum*, *Pogonatum nanum*, *Scapania curta*, etc. The fruit had just ripened on Aug. 2nd, but the lids had not been thrown off.

Note. *Leucobryum glaucum* is recorded by Vahl and Hornemann as found in Iceland, but neither the name of the finder nor the habitat is given. No specimens of this species are to be found in the collections.

Fam. FISSIDENTACEÆ.

39. **Fissidens bryoides** (L.) Hedw.

N. Iceland: Hof near Eyjafjördur (O. D.)!. S. Iceland: Krokur (H. J.)! Almannagjá!.

In Almannagjá it grew very scantily among other mosses on soil-covered stones at the bottom of a lava-cleft. Near Hof it grew on damp ground by a waterfall. The fruit, on the specimens from both localities, was ripe when collected (June 12).

40. **Fissidens osmundoides** (Sw.) Hedw.

Common on damp ground in bogs, at the base of rocks, in rock-clefts, etc., sometimes in low, dense tufts, sometimes mixed with other mosses. The plants are almost always found sterile. Only in Reykholtdalur, where it grows very abundantly on warm, boggy ground, has it been collected in fruit. It is most widely distributed in the lowlands up to about 300 metres above sea-level, but it may occur, although scantily, as high as about 500—600 metres.

41. **Fissidens adianthoides** (L.) Hedw.

N. Iceland: Hof near Eyjafjördur, fr. (O. D.)!. W. Iceland: Kleppjarnsreykir (Grl.)!; Laugarnir near Reykjavik (Grl.)!; bog near Reykjavik, fr.!; Kollafjördur!

Rare and scanty on boggy or warm ground.

Note. *Fissidens taxifolius* is recorded by Zoëga and Hornemann from Iceland (without finder, habitat or specimens in the collections) and by Grönlund from Mývatn; but Grönlund's specimen belongs to *F. osmundoides.*

42. **Fissidens decipiens** De Not.

W. Iceland: Sandur (H. J.)!; Hafnarfjördur!.

This plant grew in both localities in lava-clefts, associated with *Lejeunea serpyllifolia.*

Fam. SELIGERIACEÆ.

43. **Blindia acuta** (Huds.) Br. eur.

Very common on wet rocks in or by rivers and waterfalls up to about 400—500 metres above sea-level, occasionally also on the ground and often in great abundance. The fruit, which is almost always present, ripens in the beginning of July.

At a greater altitude it occurs more scantily, but may nevertheless be met with as far upwards as 600—700 metres.

Fam. DITRICHACEÆ.

44. **Ceratodon purpureus** (L.) Brid.

Common on rocks, lava-flats, sandy soil, peat, etc. especially in N. and NW. Iceland, and on lava-flats in the interior of the country. It is less frequent in E. and S. Iceland. The fruit, which is usually present, ripens in the first half of July.

It varies considerably, especially in leaf-form. Forms with shortly pointed or almost obtuse leaves (var. *brevifolius*) are the most frequent.

45. **Ditrichum tortile** (Schrad.) Lindb.

E. Iceland: Seydisfjördur!, sterile.

It was growing there on damp gravelly soil along a river, interspersed in a Hepaticæ-mat formed by *Alicularia scalaris, A. geoscypha, Anthelia Juratzkana, Lophozia ventricosa, etc.*

46. **Ditrichum nivale** (C. M.) Limpr.

E Iceland: Berufjardarskard!, at an altitude of about 500 metres, fr.

The plant was growing very scantily in a cushion of *Anthelia Juratzkana.*

The entire height of the plant was about 6 mm. The seta was about 5 mm. high. The capsules were, without the lid, about 0.5 mm. long.

47. **Ditrichum homomallum** (Hedw.) Hampe.

Fl. Dan. tab. 2688, ex Islandia leg. Mörch. E. Iceland: Vestdalur near Seydisfjördur!, sterile. N. Iceland: Hof near Eyjafjördur (O. D.)!, sterile. W. Iceland: Reykjavik (Grl.;!), fr.; hot spring near Grafarbakki (F.)!, sterile; Hafnarfjördur, at the bottom of a lava cave!, sterile. S. Iceland: Geysir! ♀.

Around Reykjavik it was rather common along the side of ditches. There the fruit was ripe on August 7th. Near Geysir it occurred in extensive mats, about 1—2 cm. deep, on warm clayey flats with a temperature of 35—40°.

48. **Ditrichum flexicaule** (Schleich.) Hampe.

One of the most commonly occurring mosses; it is met with on almost every substratum and at all altitudes. It grows both on damp or soil-covered rocks and in bogs, where it especially occurs woven into the tufts found there, and on damp or on more dry gravelly soil, in lava caves, in grass fields, in heaths, etc.

This species varies considerably, especially as regards the length and direction of the leaves. Short-leaved forms (*f. brevifolia*) are frequent on more dry ground, where they form dense tufts with stiffly erect or slightly secund leaves. On damp ground and especially in sheltered localities, for instance among stones, or in clefts, the leaves become longer, often strongly secund, and the tufts higher and looser. Fruit it very rare. Near Seydisfjördur, in the beginning of July, the setæ had not developed to their full length and the capsules were barely formed.

49. **Sælania cæsia** (Vill.) Lindb.

Ditrichum glaucescens (Hedw.) Hampe.

E. Iceland: Breiddalur!; Hallormstadr!. N. Iceland: Vidimýri (Grl.)!; several places near Eyjafjördur (O. D.;!). W. Iceland: Husafell (Grl.)!; Kalmanstunga (Grl.)!; Gilsbakki!; Hafnarfjördur!; Esja!. S. Iceland: Skálholt!; common near Thingvellir!.

This species is rather common, especially in W. and SW. Iceland, in soil-filled rock and lava clefts, as a rule associated with *Mnium orthorrhynchum*, *Plagiothecium Roeseanum*, *P. pulchellum*, *Pohlia cruda*, *Distichium montanum*, etc.

In the wood by Hallormstadr it was growing on the ground in company with *Bartramia ityphylla*, *Pohlia cruda*, *Distichium inclinatum* and *Ditrichum flexicaule*. The fruit, which is almost always present, ripens in the middle or at the end of June. The plant has not been observed at a higher altitude than about 200—300 metres.

50. **Distichium montanum** (Lam.) Hagen.

Distichium capillaceum (Sw.) Br. eur.; *Swartzia montana* (Lam.) Lindb.

Very common all over Iceland.

Distichium montanum is one of the most widely distributed mosses in Iceland. It is found everywhere on almost every kind of substratum, with the exception of that which is very wet, from the bottom of the valley up to a height of about 500—600 metres above sea-level. At greater altitudes it is more rare, but may nevertheless be met with as far upwards as to the snow-limit, in sheltered localities among stones.

This species has its main distribution in the more low-lying regions where, either intermixed with other species or in unmixed tufts, it is hardly absent from any cleft or soil-filled rock-crevice, but it also occurs everywhere intermixed in the moss-covering at the bottom of grass-fields, in bogs, on rocks, etc.

The fruit, which is almost always present, ripens in the latter half of July.

51. **Distichium inclinatum** (Ehrh.) Br. eur.

Swartzia inclinata Ehrh.

E. Iceland: Vallanes!. N. Iceland: Near Dettifoss!; Husavik!; Hof near Eyjafjördur (O. D.)!; Öxnadalur!; Vidimýri!. NW. Iceland: Gnupsdalur in Dýrafjördur!.

It was also collected by Steenstrup, but no habitat is given. Grönlund records this species from Hafnarfjördur, but the specimens in the Botanical Museum belong to *Distichium montanum*.

This plant was only found in the northern half of Iceland, where it occurred in many places from Vallanes in the east to Dýrafjördur in the north-west, and especially in North Iceland proper. It grows as a rule on damp ground, although not very abundantly, for instance along streams, associated with *Dichodontium*, *Didymodon rubellus*, *Hepaticæ*, etc. Near Vidimýri it was growing along the banks of streams, mixed with *Scapania curta*, *Lophozia Mülleri*, *Haplozia atrovirens*, *Dichodontium* and *Bryum pallens*; near Dettifoss on glacier-sand, in company with *Ceratodon purpureus* and *Aongstræmia longipes* and near Husavik on damp sandy soil, with *Aongstræmia*, *Dichodontium* and *Philonotis tomentella*. In several places it was collected on peaty soil in association with *Meesia trichoides*, *Catoscopium nigritum*, *Barbula rubella*, *Aongstræmia*, *Lophozia Wenzelii*, etc.

In North Iceland proper the fruit was almost ripe at the end of July.

52. **Bryoxiphium norvegicum** (Brid.) Mitten.

Eustichium norvegicum Br. eur.

S. Iceland: Krisuvik (Mörch)!; Thingvellir (Mörch)!; glacier originating from the Jökul (Stp.)!; Kolvidarhol!; Flokastadagil!; Barkarstadr!; Drángshlid!.

This species was only found in the south-western part of the

country, where it is common in many places and often occurs in enormous quantities. Mörch records that it grows in holes in the lava. Near Kolvidarhol it was found everywhere on tuff, from the farm (at about 250 metres up to about 450 metres above sea-level; it was found in extensive mats, especially on the vertical or overhanging sides of the tumbled-down blocks, and in the interior of holes and clefts. It was most frequent on Fljótshlid and south of Eyjafjall. There it was growing in many places on the vertical sides of tuff-rocks in the ravines and on the fallen blocks, for instance in Flokastadagil near Breidabolstadr it covered long stretches of the perpendicular sides of a ravine, from a distance of a few cm. above the water-level of the river upwards, with a dark-green closely adhering mat in which almost no other mosses were intermixed. In this part of the country it has only been met with up to about 100 metres above sea-level. Only sterile specimens have been found.

Bryoxiphium norvegicum is the only Iceland moss which does not occur on the European continent or in the British Isles. Outside Iceland it has only been known to occur in a few localities in North America (Ohio, Kentucky and Wisconsin).

Fam. POTTIACEÆ.

53. **Pottia Heimii** (Hedw.) Br. eur.

Iceland (Mörch)!

E. Iceland: Hornafjördur!. N. Iceland: near Eyjafjördur (F.)!; Saudanes (St.)!; Grimsey (O. D.)!. NW. Iceland: Ármuli!. W. Iceland: Reykjavik (Grl.;!); Borgarnes!. S. Iceland: Vestmannaey!.

This species grows on sandy or muddy soil near the sea, and is probably commonly distributed along the whole coast in such localities. Around Reykjavik, on Vestmannaey and near Hornafjördur it was common, and was frequently found also on soil-covered rocks and in rock-clefts close to the sea.

The fruit ripens about July 1st; on Grimsey the fruit was fully ripe on July 14th, but the lids had not been thrown off. Near Ármuli it was hardly ripe during the first days of July.

54. **Pottia latifolia** (Schwägr.) C. M.

N. Iceland: Hof near Eyjafjördur (O. D.)!; Ós (O. D.)!, with ripe capsules on June 17th.

Note. *Pottia truncatula* and *P. lanceolata* are enumerated in older lists as found in Iceland, but no specimens of these species are to be found in the collections, and their occurrence in Iceland is very improbable.

55. **Didomodon rubellus** (Hoffm). Br. eur.

Barbula rubella (Hoffm.) Mitten.

Very common everywhere on a more or a less damp substratum, in rock-clefts, on the ground, on rocks and gravelly soil by rivers, in bogs, etc. It grows sometimes in unmixed tufts and sometimes inter-

mixed with other mosses, and as a rule sets fruit, which ripens late in August or early in September. It is most frequent in the low land up to about 300 metres above sea-level, but is also met with, although scantily, and often sterile, as far upwards as to the mountain heights, for instance on Isafjardarheidi, about 600 metres above sea-level.

Forms which must be referred to var. *brevifolia* Lindb. et Arnell occur commonly together with transitional forms to the type. Near Seydisfjördur the variety was found abundantly in reddish brown, dense tufts, about 5 cm. high, in rock-fissures filled with soil.

Note. *Didymodon tophaceus* is recorded by Lindsay from Iceland, but no specimens are in the collections and the record is probably due to an erroneous determination.

56. **Didymodon rufus** Lorentz.

E. Iceland: Stafafell!; Geithellir!. N. Iceland: Stadr near Hrutafjördur!; Akureyri, at an altitude of 900 metres!. W. Iceland: Lundur! Breidabolstadr in Reykholtdalur!.

The plant, which was only found sterile, grew in all the above localities in loose tufts, a few cm. high, on damp gravelly ground, as a rule rather scantily. Near Akureyri it grew scantily among *Sphærocephalus turgidus* and *Rhacomitrium hypnoides*.

57. **Leptodontium flexifolium** (Dicks.) Hampe.

N. Iceland: Grimsey (O. D.)! (f. *compacta*).

Enumerated in Lindsay's list, but neither the name of the finder nor the habitat is given.

58. **Trichostomum littorale** Mitten.

Mollia littoralis (Mitten) Braithw.

S. Iceland: Helgafell on Vestmannaey, on blocks of lava!; Hafnarfjördur, in a lava cave!; on warm clayey flats near Reykjanes lighthouse (Ostf.)!, associated with *Preissia*, *Riccia* and *Archidium*.

59. **Tortella inclinata** (Hedw.) Limpr.

Mollia inclinata (Hedw.) Lindb.

E. Iceland: Vallanes (H. J.)!.

60. **Tortella tortuosa** (L.) Limpr.

Mollia tortuosa (L.) Schranck.

Very common all over Iceland.

This species has its main distribution in the low land up to about 400 metres above sea-level. It appears to be rare everywhere at higher levels, and hardly ascends higher than about 600 metres. It grows

both on rocks and on earth. In lava-fields it is one of the most commonly occurring species, and grows there in enormous cushions on rock-sides in caves and clefts, in association with *Amphidium Mougottii*, *Anœctangium compactum* and *Grimmia torquata*. On rocks it grows on perpendicular faces, on soil-covered ledges, and in clefts. On the ground it is found especially where it is not too damp, for instance in grass-fields and on the top of knolls in bogs, usually intermixed in tufts of other mosses. At higher altitudes it rarely grows on rocks, but as a rule on gravelly ground or in bogs. Only sterile specimens have been found.

This species varies considerably in the size and length of the leaves. Forms from shady and protected localities, especially from lava-clefts, form very tall and loose tufts with exceedingly long and strongly crisped leaves.

61. **Tortella fragilis** (Drumm.) Limpr.

Mollia fragilis (Drumm.) Lindb.

Commonly distributed all over Iceland.

This species grows in localities similar to those of *T. tortuosa*, and often in company with the latter, but as a rule rather scantily. It usually occurs in unmixed tufts on soil-covered rocks and on somewhat damp ground, but only sterile specimens have been found. Around Reykjavik, for instance, it was common on knolls in boggy tracts which had been partially drained. In NW. Iceland it is rather rare, and has only been found in a few localities near Kaldalon.

62. **Barbula unguiculata** (Huds.) Hedw.

var. ***cuspidata*** (Schultz) Braithw.

S. Iceland: Vestmannaey!, on damp gravelly soil near the town. It has previously been collected here by an unknown finder (H. Jonsson believes by G. Brynjolfsen). W. Iceland: Saurbær near Hvalfjördur, at an altitude of about 100 metres, on soil-covered rocks. In both places only sterile specimens have been found.

63. **Barbula fallax** (Hedw.).

S. Iceland: Reykir ♀. W. Iceland: Saudlauksdalur (H. J.).

Var. *lævifolia* n. var.

In wide dense cushions, 2—3 inches deep, rusty brown in the interior, brownish green at the top. The lower leaves as in the type, the uppermost shortly pointed with rounded, broad and flat apex, into which the strong nerve runs out, widely revolute to near apex, with two deep plicæ at the base. Leaf-cells in form and size as in *B. fallax*, in the lower half of the uppermost leaves, however, more thin-walled, shortly rectangular; all quite smooth or, more rarely, indistinctly papillose. The innermost perichætial leaves ovate or widely lanceolate, with faint or indistinct nerves.

S. Iceland: Thorlákshver, on warm clayey ground.

Although this form differs somewhat from *B. fallax* in habit, in the smooth leaves with rounded apex, and in the divergent form of the perichætial leaves, yet there is hardly any doubt that it must be referred to this species. Setting apart the absence of papillæ the leaf-tissue is quite typical, and the form and the plication of the lower leaves are exactly as in *B. fallax*. It should be remembered that the occurrence on a warm substratum produces very divergent forms also in other mosses, e. g. *Philonotis*, *Catharinea* and *Oligotrichum*. Near Reykir, *B. fallax* was collected both on stones by the river, in sand-

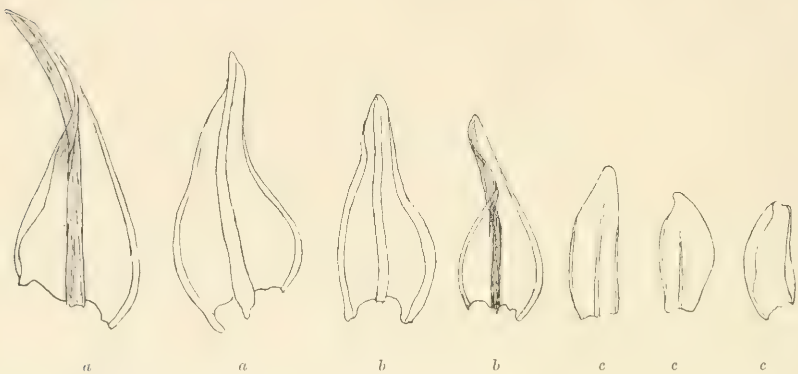


Fig. 1. *Barbula fallax* Hedw. *a*, Leaves of the plant from Reykir (× 20). *b*, Leaves of var. *lævifolia*; *c*, perichætial leaves of same.

filled tufts about 2 cm. high, in a somewhat typical form, and on a warm, damp substratum. Plants from the latter locality form a transitional stage to var. *lævifolia*. It grew in somewhat loose tufts, 3—4 cm. high, which in colour and appearance agreed with var. *lævifolia*. The lowermost leaves are pointed, the uppermost rounded; the perichætial leaves are lanceolate, rounded, with rather faint nerve. The leaf-cells are distinctly papillose, sometimes as highly as in the typical form, sometimes much more faintly.

64. **Barbula cylindrica** (Tayl.) Schimp.

N. Iceland: Hof near Eyjafjördur (O. D.)!. S. Iceland: Vestmannaey!; Ýtri Skogur (H. J.)!; Fljótshlid!; Holt!; Drángshlid!; Hornafjördur!. W. Iceland: Esja near Kollafjördur!.

This species occurred commonly, and often abundantly, on tuff-rocks in S. Iceland and on Vestmannaey. There it also grew abundantly on sandy soil and on lava blocks near the sea. In the other localities it was found but scantily. Fruit was collected only near Holt, where, at the end of July, both old and yet green capsules were collected from the same tuft.

65. **Barbula icmadophila** Schimp.

SE. Iceland: Hornafjördur!, in several places in small quantities. N. Iceland: Skagafjördur (Grl.)!; Hofsfjall near Eyjafjördur (O. D.)!. W. Iceland: Esja, at an altitude of 400 metres!.

This species has been collected everywhere only in small quantities, in cushions 1—2 cm. deep, on humus-covered rocks.

66. **Desmatodon latifolius** (Hedw.) Br. eur.

Tortula latifolia (Hedw.) Lindb.

E. Iceland: Djupivogur!, common near the sea; Vallanes!; Hamarfjördur!; Berufjördur!. N. Iceland: Husavik! at an altitude of about 400 metres; Reykjahlid!; Grimsey (O. D.)!; Stadr near Hrutafjördur!. NW. Iceland: Isafjördur!; Grunnavik!; Hesteyri!; Arngerdaeyri!; W. Iceland: Stykkisholmur!.

Var. ***muticus*** Brid.

Grimsey (O. D.)!; Reykjahlid!; Isafjördur!, 450 metres above sea-level. Found in all the localities together with the type.

In NW. Iceland *D. latifolius* is one of the most frequently occurring species, and the same appears to be the case in E. Iceland. It occurs especially near the sea on sandy soil or, also, on humus-covered rocks, and often abundantly. Near Vallanes it grew in masses on peat walls and on dikes around the farm, associated with *Encalypta rhabdocarpa*, *Tortula subulata*, *Ceratodon purpureus*, *Bryum argenteum*, *Bartramia ityphylla*, etc.

In N. Iceland this species occurs more sporadically. Near Husavik only a single little tuft was found on the top of Husavikurfjall; near Reykjahlid it was common in lava-fields, in places covered by a thin humus-layer, associated with *Ceratodon purpureus*, *Tortula ruralis*, *T. subulata*, etc., and near Stadr it grew on the peat walls of the farm exactly as it grew near Vallanes. From SW. and S. Iceland this species appears to be quite absent, and in W. Iceland it was only found near Stykkisholmur, where it was found abundantly on earth and rocks along the shore.

It is only by exception that *Desmatodon latifolius* has been found at higher altitudes. Near Isafjördur it occurred here and there on the rocky flat up to a height of about 500 metres, for instance on a stony slope 450 metres above sea-level, associated with *Bryum elegans*, *Bartramia ityphylla*, *Pohlia commutata*, *Scapania curta* and *Encalypta rhabdocarpa*. The fruit, which was present everywhere in abundance, ripens at the end of June.

67. **Desmatodon cernuus** (Hübn.) Br. eur.

Tortula cernua (Hübn.) Lindb.

N. Iceland: Hof (O. D.)!; Hjalteyri (O. D.)!.

On the plant from Hjalteyri the fruit had just ripened on September 5, 1897.

68. **Tortula obtusifolia** Schleich.

S. Iceland: Flokastagil on Fljótshlid!; Drángshlid!.

This very rare species was found in both places in very small cushions, only 5—6 mm. deep, with numerous capsules which were almost fully ripe in the latter half of June. In Flokastadagil it grew here and there on fallen blocks, especially in small fissures on the vertical rock-faces. Near Drángshlid it was found in small quantity on the dry faces of tuff-rocks in company with *Tortula muralis*, *Grimmia Doniana* and *Orthotrichum anomalum*.

69. **Tortula muralis** (L.) Hedw.

S. Iceland: Vestmannaey!; Drángshlid!.

The plant was found very scantily in both places on dry faces of tuff-rocks. On Vestmannaey it grew on a rock-face with a southern exposure, associated with *Grimmia maritima* and *Barbula cylindrica*; near Drángshlid it grew in association with *Grimmia Doniana* and *Tortula obtusifolia*.

70. **Tortula subulata** (L.) Hedw.

Commonly distributed over the whole of Iceland.

The plant grows almost exclusively in the low land up to about 300 metres above sea-level, and only in quite a few localities in S. Iceland has it been found at a higher level, for instance near Barkastadr at an altitude of 410 metres. It is most frequent in S. and E. Iceland; in N. and NW. Iceland it is somewhat less common, but has nevertheless been collected from a great number of places. It usually grows on a rather dry substratum, e. g. humus-covered rocks, in rock-clefts, on dikes and on peat walls of houses, mostly associated with *Bartramia ityphylla*, *Pohlia cruda*, *Encalypta rhabdocarpa*, *Brachythecium albicans* and other species. Fruit, which is always present, ripens in the end of June or in the beginning of July.

71. **Tortula mucronifolia** Schwgr.

Vestmannaey!.

It occurs here in localities quite similar to those of *Tortula subulata*, for instance on dikes, in sandy soil and on humus-covered rocks, and appears to be as frequent as this. The fruit was not yet quite ripe towards the middle of June.

72. **Tortula ruralis** (L.) Ehrh.

Commonly distributed over the whole of Iceland.

Tortula ruralis is a decidedly xerophilous species, and has, therefore, its widest distribution in the driest parts of the country. In the lava-fields in the interior, for instance around Mývatn, it occurs abundantly; in NW. Iceland it is also more frequent than in the other parts

of the country, especially E. Iceland, where it occurs but scantily in many districts.

It grows in sandy soil, upon soil-covered rocks and at the base of vertical rock-faces, and is most frequent in the low land. Near Akureyri it was found with ripe fruit (20. 7. 1909). Near Grunnavik in Jökulsfjördur it was found in fruit at an altitude of 270 metres. In Esja it has been collected up to about 420 metres above sea-level. Near Vallanes the fruit was ripe about July 1st. At the coast, near Reykjavik, it grew abundantly in large tufts which were quite filled with sand.

73. **Tortula aciphylla** (Br. eur.) Hartm.

T. norvegica (Web.) Wahlb.

NW. Iceland: Dyrafjördur!, at an altitude of 150 metres.

It grew there in cushions, about 2 cm. deep, on humus-covered rocks. The capsules were quite green on June 17th.

The leaf-form, nerve and leaf-hair in these specimens were quite typical, but the cells of the leaf-base were occasionally chlorophyllose towards the margin, forming a more or less distinct border, in which feature it approached *Tortula ruralis*.

Fam. GRIMMIACEÆ.

74. **Schistidium maritimum** (Turn.) Br. eur.

E. Iceland: Hornafjördur!; Hof!; Hamarfjördur!; Djupivogur!. N. Iceland: Husavik!; Grimsey (O. D.)!. NW. Iceland: Common everywhere along the coasts!. W. Iceland: Stykkisholmur; Hafnarfjördur!; Reykjavik (Grl.;!); by Hvalfjördur (Grl.)!. S. Iceland: Vestmannaey!.

This plant doubtless occurs everywhere along rocky shores. It is, however, absent from, or only occurs scantily in, the interior of deep, narrow fjords. Thus, around Berufjördur it is very common towards the entrance of the fjord, near Djupivogur, while it is entirely absent from the head of the fjord.

As a rule it grows only on rocks quite close to the sea, and up to a height of some 10 metres. More rarely, for instance near Djupivogur and on Vestmannaey, it descends to the sandy ground at the foot of cliffs.

Fruit is almost always present abundantly.

75. **Schistidium apocarpum** Br. eur.

Grimmia apocarpa Hedw.

Subsp. ***vulgare*** (Chal.) Loeske.

Common over the whole of Iceland.

It grows, as a rule, on rather dry rocks, occasionally also in gravelly soil, but then rarely in any great abundance. It is most frequent

in the more low-lying parts of the country, but may, however, occasionally be met with upwards of 600 metres above sea-level.

76. **Schistidium apocarpum** Br. eur.

Subsp. ***gracile*** (Schwägr.) Loeske.

Very common.

One of the most frequent mosses, and met with from the lowlands up to mountain heights. It occurs, in numerous forms, both on dry and on damp rocks, and on more or less damp gravelly soil. On gravelly flats, especially above an altitude of about 300 metres, it often forms extensive growths. It occurs also very abundantly on tuff-rocks (for instance in Esja and below Eyjafjall) in a low, reddish-brown form. Fruit is always present.

77. **Schistidium apocarpum** Br. eur.

Subsp. ***confertum*** (Funck) Dixon.

E. Iceland: Hof!; Seydisfjördur!. N. Iceland: Husavik, at an altitude of about 400 metres!; Reykjahlid!; between Hnausar and Lækjarmot!; Vidvik (P. Sófóniasson)!, several places near Eyjafjördur (O. D.)!.

This form has its main distribution in N. Iceland, where it is rather common; thus, near Reykjahlid it was found abundantly on lava-blocks. It grows by preference on rather dry rock-faces, or upon stones, and has been gathered everywhere in fruit.

78. **Schistidium alpicola** (Sw.) Limpr.

Var. ***rivularis*** (Brid.) Wahlb.

Very common in E., N. and W. Iceland, more rare in S. Iceland, where it is absent from many localities.

This species grows on stones and rock surfaces in rivers, often in great abundance, covering the banks and the stones in the water for long distances. It does not appear to ascend much higher than about 300—400 metres above sea-level.

The chief reason for its occurring more scantily in South Iceland must be sought in the fact that the water in many rivers is turbid, owing to the glacier-clay carried in them. In this part of Iceland it is met with especially in rivers with clear water, at an altitude of 200—400 metres, more rarely in the low land.

Var. ***eualpicola*** Loeske. *Grimmia alpicola* Swartz.

N. Iceland: Dettifoss!, fr.

This form, which in the above locality grew on blocks of basalt at some distance from the waterfall, but nevertheless exposed to the spray, appears to be as rare in Iceland as in most of the rest of Europe. Forms intermediate between this form and var. *rivularis*, have not been collected.

79. **Grimmia commutata** Hübener.

Grimmia ovalis (Hedw.) Lindb.

N. Iceland: Mývatnshraun (St.)!. W. Iceland: Budir (H. J.)!. In the supplement to "Isl. Kryptogamflora" (B. T., vol. 20, p. 105 Grønlund has recorded *G. ovata* from Mývatnshraun and *G. commutata* from Vallanes and Kolfreyjustadr. But according to the specimens in the Botanical Museum in Copenhagen, determined by C. Jensen, the plant from Mývatn is *Grimmia commutata* and those from the two other localities are *G. ovata*. Grønlund has, therefore, probably confused the two names (*G. ovata* and *G. ovalis*) used by C. Jensen.

80. **Grimmia Doniana** Smith.

E. Iceland: Common from Hornafjördur to Seydisfjördur!. N. Iceland: Hólar (Grl.)!; Vidimýri (Grl.)!. NW. Iceland: Dýrafjördur!; Gnupsdalur!; Dýnjandi!. Common in SW. and S. Iceland.

With the exception of N. Iceland, where it appears to be rare, this species is widely distributed in the more low-lying districts of the country, as it is only by exception that it ascends higher than 200—300 metres. Near Holt in S. Iceland it has, however, been collected plentifully at about 500 metres above sea-level. It usually grows in small, round tufts on loose blocks, more rarely in wide cushions, irregular in form. In South Iceland proper — for instance near Drángshlid — it occurs also on faces of tuff-rock. The fruit, which occurs everywhere, was hardly ripe even at the end of July.

81. **Grimmia alpestris** Nees.

E. Iceland: Arnkelsgerdi; Eidar (H. J.)!, sterile. S. Iceland: Hafursholt!, fr.

82. **Grimmia ovata** W. et M.

Grimmia ovalis Lindb.

Iceland leg Mörch!. E. Iceland: Kolfreyjustadur (H. J.)!; Vallanes (H. J.)!; Seydisfjördur!; Berufjördur!. N. Iceland: Hnausar in Vatnsdalur!; Reykjaheidi!; Herjardalsheidi (Grl.)!. Only sterile specimens have been found.

This species grows on dry stones and rocks; it is rather frequent in East and North Iceland, but has not been found in the other parts of the country.

83. **Grimmia incurva** Schwgr.

E. Iceland: Vallanes!.

It was growing in the above locality on a slightly inclined, partly inundated rock-surface in the river Lágarfljot.

84. **Grimmia patens** (Dicks.) Br. eur.

Dryptodon patens Brid., Limpr.

E. Iceland: Hornafjördur!. W. Iceland: Budahraun (H. J.)!; Hafnarfjördur!.

In Budahraun it was growing in the clefts in the lava-field; near Hafnarfjördur it was found in abundance associated with *Orthotrichum rupestre* and *O. Sturmii* on the face of a dolerite rock with a northern exposure.

85. **Grimmia funalis** (Schwgr.) Sch.

Widely distributed over the whole of Iceland.

G. funalis is by far the most frequent species of this genus. It grows everywhere on dry rocks, especially on the vertical sides of ravines and lava-clefts, where it forms immense cushions, often 5—6 cm. deep, which very easily break up into pieces when loosened from the substratum. The fruit, which occurs rather frequently, was not ripe even in August. This species is most frequent up to about 300—400 metres above sea-level, but often ascends, however, to somewhat above 500 metres, for instance near Akureyri.

86. **Grimmia torquata** Hornsch.

E. Iceland: Hornafjördur!, very common; Seydisfjördur!. N. Iceland: near Hrutafjördur (H. J.)!. NW. Iceland: Dýnjandi!; Grunnavik!; Arngerdareyri!. W. Iceland: Melar (Grl.!; Hafnarfjördur (Grl.;!); Budahraun (H. J.)!. Very common in SW. Iceland!.

This species in very common in SE., S. and SW. Iceland, rather rare in N. and NW. Iceland. It grows on dry rock-faces in ravines and lava-clefts, but only sterile specimens have been found.

Note. *Grimmia pulvinata* is enumerated in several older lists, but these records are probably due to a confusion with other species.

87. **Rhacomitrium sudeticum** (Funck) Br. eur.

Grimmia microcarpa (Gmel.) Lindb.

Common over the whole of Iceland.

In many parts of Iceland *R. sudeticum* is one of the most frequent species, being found from the sea-level up to the gravelly flats of mountain heights. It is most widely distributed in NW. Iceland and along several fjords in E. Iceland, for instance Seydisfjördur, while it appears to occur less abundantly in N. Iceland. It grows on rather dry rocks and blocks of lava, in clefts, and on wet stones in and by streams. In mountain heights, especially in NW. Iceland, it forms the bulk of the vegetation on gravelly flats from about 300 metres upwards.

It varies considerably in size, habit, colour and length of hair point. On wet rocks it becomes very large, and almost black, with very short hair point, while the forms growing on dry rocks are as a rule very low in growth and slender, often occurring in small round, compact tufts, blackish green or brownish red in colour, with longer

hair point. In the birch coppices of NW. Iceland a form frequently occurs on larger, scattered stones which, in habit, reminds one of *R. fasciculare*. The tufts are flat towards the edge, dark-green; the hair point is very short and often wanting. The forms from mountain heights are often jet-black (var. *atrata*) or — on damp gravelly flats — yellowish green at the top, and grow in extensive, discontinuous mats, a few cm. thick. The fruit, which is very common, ripens in the beginning of June.

88. **Rhacomitrium heterostichum** (Hedw.) Brid.

E. Iceland: Hornafjördur!; Hof!; Geithellir!; Berufjördur!. N. Iceland: Akureyri!, at an altitude of 350 metres. NW. Iceland: Patreksfjördur!; Arngerdareyri!. Common in S. and W. Iceland!.

Common throughout E. Iceland, from Berufjördur, and southwards through the whole of S. and W. Iceland.

In W. Iceland it occurs abundantly at the head of Isafjördur, near Arngerdareyri, but has not been collected about the fjord further outwards towards its entrance; it was also common by Patreksfjördur. It appears to be more rare in N. Iceland.

The plant grows most frequently on dry rocks, and more rarely on those that are damp; it occurs in masses, for instance, in the lava districts of SW. Iceland. It is most common in the low land, but is, however, also met with at about 600 metres above sea-level. Fruit is rather common.

89. **Rhacomitrium microcarpum** Brid.

Grimmia ramulosa Lindb.

N. Iceland: Hof by Eyjafjördur (O. D.)!, sterile.

Recorded by Grönlund from Reykjavik and Husafell, but the specimens in the Botanical Museum in Copenhagen must be referred to *R. canescens*.

90. **Rhacomitrium canescens** (Weis) Brid.

Very common.

Next to *R. hypnoides* the most widely distributed species, and met with as frequently on mountain heights as in the low land, and in numerous forms. It grows both on rocks and on earth, especially where it is somewhat damp. In the "*Grimmia* heath" it often covers the more low-lying tracts with its light yellowish-green to greyish-green mats, while *R. hypnoides* grows in the more dry parts, but both species often occur mixed. It is also the most abundant constituent of the vegetation on damp sandy or gravelly soil by streams, in grass-fields with a poor soil, etc. Forms with the hair point entirely or almost wanting (*f. epilosa*) are frequent in wet localities.

Fruit is only rarely and scantily met with. Near Hof in E. Iceland plants were found in the middle of June with old capsules, and near Sugandafjördur about July 1st with yet green capsules.

91. **Rhacomitrium hypnoides** (L.) Lindb.

Grimmia hypnoides Lindb.; *Rhacomitrium lanuginosum* (Ehrh.) Brid.

Very common over the whole of Iceland.

Rhacomitrium hypnoides is by far the most common plant in Iceland. In all parts of the country, both along the coasts and on the mountain heights, it covers, almost without any mixture of other plants, vast tracts of land — the *Grimmia* heaths so well-known also from other Arctic countries — with its thick greyish-white mats. It also occurs in almost every locality where it is not too damp, and very often intermixed in tufts of other mosses. Thus, it is very common on rocks and stones, and often covers large tracts of lava-fields with cushions one foot deep. In bogs it grows, as a rule, on the top of the knolls, in company with species of *Hylocomium*, and in birch coppices it forms, in association with *Hylocomium* spp, *Hypnum uncinatum* and several other species, the moss carpet of the floor. Only sterile specimens have been found.

92. **Rhacomitrium fasciculare** (Schrad.) Brid.

Very common in the Southern, Western and Eastern parts of Iceland. In N. and NW. Iceland it appears to be somewhat less plentiful, but nevertheless it must also there be regarded as one of the more commonly occurring species.

It occurs at all altitudes up to the limit of vegetation on mountain heights. It forms, there, like *R. sudeticum*, black Alpine forms on dry rocks.

This species usually grows on stones and rocks in dry situations, but it also occurs frequently in gravelly soil. Occasionally it may even be found in the lowermost portion of birch-trunks. The fruit, which is rather common, ripens in the lowlands in the first half of June.

93. **Rhacomitrium aciculare** (L.) Brid.

Very common on wet rocks in and by rivers and waterfalls everywhere in the low-lying parts of the country. It does not appear to ascend much higher than 300—400 metres. The fruit, which occurs everywhere, ripens, as a rule, in the beginning of June.

Note. *Grimmia* (*Rhacomitrium*) *elliptica* is recorded in older lists as found in Iceland by Mörch. The specimens in the collections belong to *R. fasciculare*.

Cinclidotus fontinaloides, also, is recorded by Hornemann as found in Iceland, but it was undoubtedly confused with another species. Specimens are not to be found in the collections.

94. **Hedwigia albicans** (Web.) Lindb.

Hedwigia ciliata Ehrh.

SW. Iceland: Hafnarfjördur (Grl.)!, sterile.

FAM. ORTHOTRICHACEÆ.

95. **Amphidium lapponicum** (Hedw.) Schimp.

Anœctangium lapponicum Hedw.

Very common.

This species usually grows on damp rocks, especially in clefts and crevices, but may also occur on a more dry substratum, for instance in lava caves and among stones on heaps of debris at foot of cliffs (Urd). It grows both on bare rocks and on humus in rock-clefts, occasionally also in gravelly soil or on earth, and even upon the sides of knolls in bogs. It does not appear to ascend to any great height on the mountains; it is most widely distributed up to 200—300 metres above sea-level, but it has, however, been found, although scantily, up to about 500 metres above sea-level.

The fruit was usually ripe in the first half of June.

96. **Amphidium Mougeotii** (Br. eur.) Schimp.

Anœctangium Mougeotii Lindb.

Iceland (Mörch; Stp.)!. E. Iceland: Seydisfjördur!; Stód (H. J.)!; Hof near Eyjafjördur (O. D.!); Hrutafjördur (St.)!; Myvatn (Grl.)!. NW. Iceland: Kaldalon!; Bæir!; Arngerdareyri!; Dýnjandi!. West, South-west and South Iceland: common!.

Common all over the southern and western part of the country and probably also in NW. Iceland, certainly everywhere north of Isafjördur. In N. Iceland it appears to be rarer, but occurs abundantly near Eyjafjördur. In E Iceland it is common everywhere around Seydisfjördur and is probably also frequent elsewhere. It usually grows in large, thick cushions on damp rock-sides in clefts, and by waterfalls, but is also one of the species most commonly found in lava-caves.

This species rarely ascends to any great height on the mountains. In Esja it occurred 400 metres above sea-level, and has nowhere been collected at a greater altitude. Only sterile specimens have been found.

97. **Ulota phyllantha** Brid.

Ulota maritima C. M. et Kindb.

Weissia maritima Britt.

E. Iceland: Everywhere along the coast from Hornafjördur to Berufjördur!. NW. Iceland: Frequent around Isafjördur!. W. Iceland: Snæfellsnes (H. J.)!; Stykkisholmur!; common near Reykjavik, Hafnarfjördur and everywhere around Hvalfjördur!. S. Iceland: Vestmannaey!.

This species is probably common everywhere along the coasts, where it grows in company with *Grimmia maritima* quite close to the sea-side. It is only rarely met with at a distance from the sea, as, for instance, around Reykjavik, and in a few places in the lava-fields near Hafnarfjördur. The reason why it has not been collected in North

Iceland is probably due to the fact that the coast there has been but little investigated. At Husavik the coast cliffs consist of easily weathered tuff which is very poor in mosses, the surface being too much inclined to crumble away. *Grimmia maritima* occurred also very sparingly there, and *Ulota* was not found at all. Like *Grimmia maritima* it keeps chiefly to the shores of broad fjords; therefore it was not found, or was very rare, in the interior of the deep fjords of East and North-west Iceland, nor did these two species occur at Akureyri. On Vestmannaey *Ulota phyllantha* was the most commonly distributed moss; it occurred abundantly everywhere, reaching up the face of the cliffs and being also found on that side of the latter which faced the interior of the island. It often descended to the ground, it was thus found on the knolls in a wind-torn grass-field on the slopes of Helgafell associated with *Rhacomitrium hypnoides* and *Hylocomium* spp.

98. **Orthotrichum anomalum** Hedw.

S. Iceland: Vestmannaey!; Drángshlid (H. J.;!).

On Vestmannaey it was rather frequent on tuff-rocks at the foot of Stora Klit and in Heljusdal. The fruit was ripe in the first days of June. Near Drángshlid it was found on dry tuff-rocks, associated with *O. rupestre*, *Grimmia Doniana* and *Homalothecium*. The plants from this habitat form a transition to *O. saxatile*, as slender cilia, which easily fall off, are often found on them. The capsule is however 8-striate, and the diameter of the spores is 0,012—0,018 mm. as in *O. anomalum*.

99. **Orthotrichum saxatile** Schimp.

SE. Iceland: Hornafjördur!, on rocks in company with *O. Sturmii*. The fruit was ripe in the middle of June.

100. **Orthotrichum cupulatum** Hoffm.

S. Iceland: Vestmannaey!, fr.

It was growing in the above locality on fallen blocks of tuff at the foot of Stora Klit; in the first days of June it had capsules which had just ripened.

In older lists this species as well as *O. affine* and *O. lejocarpum* is recorded from Iceland as collected by Mörch; the habitats are not given more particularly, and no specimens of these species are to be found in the collections, so all the records are probably due to confusion with *O. Blyttii*.

101. **Orthotrichum rupestre** Schleich.

Common all over Iceland except in the north-west, where it has been observed only at the head of Isafjördur near Arngerdareyri.

It grows on dry rocks and detached blocks in the lowlands, and probably does not ascend higher than about 400 metres above sea-level. The fruit ripens in the first half of July.

102. **Orthotrichum Sturmii** Hornsch.

E. Iceland: Hof!; Hornafjördur!. W. Iceland: Hafnarfjördur!; near Hvalfjördur!.

Growth similar to that of *O. rupestre*, and usually found in company with it. Near Hafnarfjördur it was found abundantly on the dry northern face of a dolerite-rock.

The plant from Hornafjördur forms in regard to the eight coarse cilia a transition to *O. rupestre*, but the upper half of the leaf consists of two layers of cells instead of only one in *O. rupestre*.

103. **Orthotrichum Killiasii** C. M.

E. Iceland: Seydisfjördur!. N. Iceland: Ásbyrgi!. W. Iceland: Dalasysla, Melar on a cliff inhabited by sea-fowl (?) (H. J.)!.

The plant from Melar, which was quite sterile, was determined by C. Jensen, but owing to the absence of fruit the determination is doubtful.

Near Seydisfjördur, where it grew on rocks close to the sea shore, the fruit was ripe about the 1st of July.

104. **Orthotrichum Blyttii** Schimp.

Iceland (Stp.)!. E. Iceland: Djupivogur!; Seydisfjördur!. N. Iceland: Geitaskard!; Vidimýri (Grl.;!). NW. Iceland: Arngerdareyri!. W. Iceland: Stykkisholmur!; Esja (Grl.)!.

Grows on rocks, especially near the coast. Thus near Djupivogur Seydisfjördur, Arngerdareyri and Stykkisholmur it was found abundantly on the rocks of the coast. But it occurs also in the interior of the country; for instance, abundantly in several localities in Blönddalur and eastwards to Vidimýri.

Grönlund's specimens are determined by Lindberg as *Orthotrichum arcticum*, but on comparing numerous specimens af *O. arcticum* and *O. Blyttii* it has not been possible for me to find any real difference between these two forms. Hagen (Musci Norvegiae Borealis. p. 83) also regards *O. arcticum* as a variety of *O. Blyttii*, from which it is said to differ both by its shorter and broader leaves and by the shorter striæ of its capsule; but both these features vary so greatly in the Iceland plants, that there is hardly any basis for establishing variety, still less for separating them into two species. The perichætial leaves are usually about 2—5 times as long as they are broad, with margins which are revolute from a short distance below the apex down to the base. The capsule is usually striated along its whole length, rarely (as in the plant from Stykkisholmur) in the upper half only. The peristome-teeth are finely papillose, rarely marked with faint sinuose lines in their lower half.

105. **Orthotrichum lævigatum** Zett.

N. Iceland: Grimsey (O. D.)!; Akureyri, 350 metres above sea-level!; Vidimýri!. NW Iceland: Arngerdareyri!. W. Iceland: Kalmanstunga (Grl.)!.

Like *O. Blyttii* it grows on dry rocks and in many places in company with this. It has been everywhere collected in fruit.

Fam. ENCALYPTACEÆ.

106. **Encalypta ciliata** (Hedw.) Hoffm.

Leersia laciniata Hedw.

Iceland (Mörch)!. E. Iceland: Hornafjördur!; Djupivogur!; Hof!; Berufjördur!. N. Iceland: Ljosavatn!; Tverá in Öxnadalur!. W. Iceland: Stykkisholmur!. Common in South and West Iceland (Grl.;!). Vestmannaey!.

This species has its widest distribution in the southern part of the country, where it is common from Berufjördur in East Iceland and thence southwards and westwards as far as Borgarfjördur. It has not been found in NW. Iceland and it is less frequent in North Iceland.

It grows sometimes in small colonies on humus-covered rocks, sometimes in rock-fissures filled with soil, usually associated with *Mnium orthorrhynchum*, *Anoectangium lapponicum*, *Bartramia ityphylla*, *Pohlia cruda*, *Distichium*, *Myurella* spp. etc. It has its main distribution in the lowlands. In Esja it ascends on exception to about 400 metres above sea-level.

In E. Iceland the fruit was quite unripe at the end of June; at Ljosavatn it had just ripened on July 19, but the calyptra still persisted. In S. Iceland, also, it ripens in the latter half of July.

107. **Encalypta rhabdocarpa** Schwgr.

Leersia rhabdocarpa Lindb.

Common in localities similar to those of the preceding species; it often occurs abundantly also on the peat-walls of houses and on walls. It is met with both near the coast and in the interior of the country — for instance, abundantly at Reykjahlid — and is frequent as far upwards as almost 500 metres above sea-level.

The fruit ripens, as a rule, at the end of June, but both overripe and just ripe capsules may frequently be found in the same tuft much later in the year.

Var. *pilifera* (Funck) Br. germ. frequently occurs in company with the type.

108. **Encalypta contorta** (Wulf.) Lindb.

Leersia contorta Lindb.

W. Iceland: Budahraun, on lava (H. J.)!, sterile.

Note. *Encalypta vulgaris* is recorded by Zoëga and Mörch, and *E. commutata* by Lindsay, but no specimens of either species occur in the collections. *Georgia pellucida* is recorded by Zoega and Vahl as found in Iceland, but of this species, also, no specimens are found in the collections, and all the above records are no doubt due to erroneous determinations.

Fam. SPLACHNACEÆ.

109. **Dissodon splachnoides** (Thunb.) Grev.

Tayloria lingulata (Dicks.) Lindb.

Iceland (Mörch !. E. Iceland: Seydisfjördur. N. Iceland: Common everywhere!. NW. Iceland: Sugandafjördur!; Isafjördur!; Armuli!; Arngerdareyri!. W. Iceland: Brattabrekka!. S. Iceland: Barkarstadr!, 550 metres above sea-level.

Grows on damp boggy ground, almost always mixed with other mosses such as *Hypnaceæ*, *Cinclidium*, *Meesia trichoides*, *Dichodontium* and *Bryum ventricosum*. In N. Iceland, where it is most widely distributed, it extends from the lowlands to a height of upwards of 600 metres above sea-level. Thus, near Husavik, it was very common in *Hypnum* bogs, and near Akureyri it was found especially in bogs at an altitude of 500—600 metres. Near Seydisfjördur it was common from about 100 metres upwards to the mountain heights. From the south-western and southern part of the country it appears to be absent, or is at any rate very rare; it was found in this part of the country only in a *Hypnum* bog near Barkarstadr, at an altitude of 530 metres.

110. **Tetraplodon bryoides** (Zoëga) Lindb.

Tetraplodon mnioides (L. fil.) Br. eur.

E. Iceland: Djupivogur!; Berufjördur!. N. Iceland: Akureyri (Carrington); Mývatn (Grl.)!; Reykir near Svinavatn (Grl. !; Flateyardalsheidi St.)!; near Eyjafjördur (O. D.)!. NW. Iceland: Dynjandi!. W. Iceland: Husafell (Grl.)!; Brunnar (Grl.)!; Reynivellir (Grl.)!; Kolvidarhol!; Hafnarfjördur!. S. Iceland: Draupahlid (Wiinsted)!.

Occurs here and there all over the country, but as a rule only in single tufts on the bodies of dead animals. Near Djupivogur a large tuft was found on a rotten fish.

The fruit, which occurs abundantly everywhere, ripens at the end of June.

111. **Splachnum sphæricum** (L. fil.) Swartz.

Splachnum pedunculatum (Huds.) Lindb.

Iceland (Mörch)!; commonly distributed!.

Grows on cow-dung in wet, marshy ground, often mixed with *S. vasculosum*, but is less frequent than the latter. It occurs most frequently in North Iceland and also, to a certain extent, in East Iceland (Seydisfjördur and Vallanes), where it is met with abundantly in many localities. it is somewhat rarer in South and South-west Iceland and probably does not ascend higher than 300—400 metres above sea-level.

The fruit ripens rather irregularly, so that in the same tuft both ripe and also quite young capsules may be found. The majority of the

fruits ripen during July; near Seydisfjördur many were found to be ripe on July 1st, and in South Iceland ripe capsules were collected between 10—15 June.

Splachnum tenue is recorded by Gliemann to have been collected by Mörch, but the specimens in the herbarium collected by Mörch belong partly to *Splachnum sphæricum* and partly to *S. vasculosum*.

112. **Splachnum vasculosum** L.

Commonly distributed.

Like the preceding species it grows, often abundantly, on cow-dung in wet marshy ground. It is most frequent in the lowlands, but ascends also as far upwards as to the mountain heights. Thus at Seydisfjardarheidi it was common up to about 600 metres above sea-level, and in NW. Iceland also it was found as far upwards as about 500 metres. Such forms from mountain heights are as a rule low in growth and have short setæ.

As is the case with *Splachnum sphæricum* the fruit ripens at different times during the course of the summer, from the first half of June into August.

Splachnum ampullaceum, as recorded to have been found by Koenig, is undoubtedly nothing else but *S. vasculosum*.

FUNARIACEÆ.

113. **Funaria hygrometrica** L.

Commonly distributed all over the country.

It usually grows on peaty ground, associated with *Dicranella crispa*, *Polytrichum gracile*, *P. juniperinum*, *Bryum* spp., etc., but is also found on humus-covered rocks and on tuff. It does not occur abundantly, as a rule, and it does not ascend to any great height, doubtless not higher than to an altitude of 300—400 metres. The fruit ripens in the beginning of August. The spores vary considerably in size in this species, from 0.011 to 0.021 mm., in plants which otherwise show no deviation from the type.

114. **Entosthodon ericetorum** (Bals. et De Not.) Br. eur.

Funaria obtusa (Dicks.) Lindb.

W. Iceland: Kleppjarnsreykir in Reykholtdalur!; Englandshver!. In both places with ripe fruit (25—30 July).

This species grew in the above localities on warm ground. Near Englandshver it grew along the outlet of a spring. Near Kleppjarnsreykir it was found both on a stone standing in water of a temperature of about 50°, mixed with *Blindia acuta*, *Aneura multifida*, *Anthoceros* and *Scapania irrigua*, and also on warm, damp ground mixed with *Fissidens osmundoides*.

Note. *Entosthodon fascicularis* is said to have been found by Hornemann near Reykjavik, but no specimens of it can be found in the collections, and the occurrence of this species in Iceland is not probable.

Fam. BRYACEÆ.

115. **Leptobryum pyriforme** (L.) Schimp.

Very common in the majority of the districts of Iceland. This species, especially in N. and NE. Iceland, is common on peat or damp ground, but also on rocks, especially in soil-filled fissures. In S. Iceland it occurs abundantly on damp rock-sides, in the clefts of tuff rocks, and by rivers. It is only in NW. Iceland that it appears to be rarer. There it is common along the sea-side around Nauteyri and Arngerdareyri, but is otherwise rare in this part of the country and has only been found close to the coast.

The fruit ripens late in summer. In N. Iceland only some of the fruits were ripe at the end of July. In specimens collected near Eyjafjördur by O. Davidsson in Sept.—Oct. the capsules were ripe, but the lids were not yet thrown off.

116. **Anomobryum filiforme** (Dicks., Lindb.) Husnot.

E. Iceland: Hornafjördur!; Berufjördur!; Stafafell!. W. Iceland: Patreksfjördur!, at an altitude of about 150 metres; Botnsdalur!; Esja, Mödruvellir!, at an altitude of about 200 metres; Álafoss!. S. Iceland: Fljótshlid, common!; Eyjafjall, common!.

Rather common in E. Iceland as far as Berufjördur, and in W. Iceland; common in S. Iceland; not found in the northern part of the country. It grows, as a rule, scantily on damp rocks, mixed with other mosses, such as *Blindia acuta*, *Anœctangium compactum*, *Amphidium lapponicum*, *Aneura pinguis*, etc., occasionally, however, also in large, pure cushions. In S. Iceland it occurred everywhere on the faces of damp tuff rocks, mixed with other mosses. Fruit was found only near Holt in S. Iceland.

117. **Anomobryum concinnum** (Spr.) Lindb.

S. Iceland: Hrutafell!.

It was growing here rather scantily on the face of a damp tuff rock, mixed with *Blindia acuta*, *Metzgeria furcata*, *Barbula rubella*, *B. cylindrica* and *Myurella julacea*.

118. **Plagiobryum Zierii** (Dicks.) Lindb.

E. Iceland: Stafafell!; Berufjördur!. N. Iceland: Mývatn (Grl.)!. NW. Iceland: Arngerdareyri!; Patreksfjördur!. W. Iceland: Nordredalur by Borgarfjördur!; Esja, in several places!; Lundur!; Bardshellir (Grl.)!;

Hafnarfjördur (Grl.)!; Geitháls!. S. Iceland: Skálholt!; Thingvellir!; Breidabolstadr!; Vestmannaey!.

Frequent in the western and south-western parts of the country from Borgarfjördur southwards, rarer in the other parts. It chiefly occurs in humus-filled rock-fissures and in lava caves, but also upon damp rocks by waterfalls, in small reddish tufts, or mixed with other mosses such as *Plagiothecium pulchellum*, *Mnium orthorrhynchum*, *Pohlia cruda*, *Myurella apiculata*, *M. julacea*, *Blepharostoma trichophyllum*, etc. It does not appear to ascend higher than about 300 metres above sea-level. Fruit has been found only in Almannagjá and very scarcely; ♀ plants are rather common.

119. **Plagiobryum demissum** (H. et H.) Lindb.

W. Iceland: Mödruvellir in Esja!.

It was growing here in company with *Anomobryum filiforme* on a stony slope at an altitude of about 200 metres. The fruit was ripe on July 17th, but the lids had not yet been thrown off.

120. **Pohlia acuminata** Hornsch.

W. Iceland: Geitabergsvatn!. S. Iceland: Seljaland!, 250 metres above sea-level; Thingvallahraun near Tintron!; Almannagjá!.

This species grows on dry stony ground in birch coppices or on rock-ledges. Thus on Thingvallahraun it grew on small slopes in the birch coppice in company with *Pohlia nutans* and *Heterocladium squarrosulum*. Near Geitabergsvatn, also, it grew on the ground in the coppice in unmixed tufts, 5—10 mm. high, with setæ, 10—15 mm. long. On July 20th the capsules were ripe, dark brown, with lids low and conical, muticous.

121. **Pohlia polymorpha** H. et H.

W. Iceland: Mödruvellir in Esja!.

It was growing in the above locality on a tuff-slope at an altitude of about 400 metres.

122. **Pohlia cruda** (L.) Lindb.

Very common.

This is one of the most commonly occurring mosses, and is of almost equal frequency at all altitudes. It usually grows in rock-clefts filled with soil and on soil-covered ledges, but is also met with both on rather dry and on damp ground, as for instance on knolls in bogs. The fruit, which is very frequent, ripens in the first half of August.

123. **Pohlia nutans** (L.) Lindb.

E. Iceland: Seydisfjördur!; Vallanes!. N. Iceland: Myvatn (Grl.)!; Hálsskogur!; Heljardalsheidi (Grl.)!. NW. Iceland: Dýrafjördur!; Isafjördur!; Sugandafjördur!; Jökulsfjördur!. W. Iceland: Breidabolstadr!; Reykjavik (Grl.). S. Iceland: Frequent near Thingvellir (Grl.)!; Draupahlid (Wiinsted)!.

P. nutans was first found in Iceland by Steenstrup, who did not, however, give the habitat. It is also recorded by Mörch, but all the specimens collected by him have been wrongly determined. It usually grows on a rather dry substratum. In the majority of the localities it occurred on the ground in birch coppices, as for instance in NW. Iceland, where it is common everywhere in the coppices at the head of the fjords. In that part of the country it also grows both frequently and abundantly on peat, and has been collected up to a height of about 350 metres above sea-level.

In the other parts of the country it is rather rare, and was as a rule found in small quantities only. Only around Thingvellir was it rather common in the birch coppices. In NW. Iceland the fruit was ripe about July 1st.

124. **Pohlia cucullata** (Schwägr.) Bruch.

Iceland (Mörch)!; Holtevad heath (Grl.)! (determined by Zetterstedt as *Webera Ludwigii*). N. Iceland: Akureyri, at an altitude of about 800 metres. NW. Iceland: Isafjördur!, at an altitude of about 350 metres; Dýnjandi!; Arngerdareyri!.

Near Akureyri it was growing in gravelly soil saturated with melting snow, associated with *Polytrichum sexangulare, Dicranum Starckei, Pleuroclada albescens,* etc. The fruit was almost ripe on July 23rd. In NW. Iceland it was common in several places north of Isafjördur on damp ground (peat) at the bottom of the valley. Here the fruit was not quite ripe in the beginning of July.

125. **Pohlia Ludwigii** (Sprengel) Schimp.

Pohlia Weigelii (Schimp.) Lindb.

N. Iceland: Ljosavatnsberg!.

In the above locality it grew abundantly on damp gravelly soil at an altitude of about 500 metres. Only sterile specimens were found.

126. **Pohlia commutata** (Schimp.) Lindb.

Very common.

Pohlia commutata is one of the most frequent species, especially in the Alpine region; at elevations from about 300 to 600 metres it is met

with everywhere on damp ground, often forming the bulk of the vegetation, for instance in several places in NW. Iceland. It is, however, also common in the more low-lying districts, where it grows especially on damp soil along streams.

Pohlia commutata is a most variable species, and occurs in Iceland in numerous forms. The tufts are, as a rule, loose, and as much as 6 cm. high. In more particularly sheltered localities, for instance in lava-clefts near Thingvellir, the plants are very vigorous, and form deep, not-coherent tufts which are hardly tomentose. But in damp depressions on the mountain heights they often form extensive, deep and dense cushions which are brownish grey in the interior and yellowish green only at the top; compact forms like this occurred abundantly on damp gravelly flats, 400—500 metres above Isafjördur. The single plants are slender, with a thin fragile stem, and with leaves appressed, shortly pointed, slightly toothed towards the apex and longly decurrent. The leaf-cells are shorter, sometimes thin-walled, sometimes rather highly thickened and porous, but both the form of the leaves and of the cells, and the thickness of the walls may vary considerably in the same tuft or even on the same plant.

The fruit, which occurs rather frequently, was usually ripe at the end of July.

127. **Pohlia gracilis** (Schleich.) Lindb.

Very common.

In the lowlands this species grows, as a rule, on damp ground along streams, either in unmixed tufts or, more often, associated with *Alicularia scalaris, Lophozia quinquedentata, Cephalozia bicuspidata, Pohlia commutata*, etc. On cold, wet gravelly ground it is sometimes the most abundant constituent of the vegetation; thus it was growing in enormous quantity below the "Jökull" in Kaldalon (NW. Iceland). In the Alpine region from about 300—700 metres, *Pohlia gracilis* is one of the most frequently occurring species, and grows everywhere on damp gravelly flats, chiefly scattered among other mosses such as *Anthelia Juratzkana, Alicularia* spp., *Polytrichum sexangulare* and *Oligotrichum hercynicum*, more rarely in larger, unmixed growths.

The fruit, which occurs very frequently, ripens on the mountain heights usually at the end of July, in the lowlands a month earlier (Kaldalon, June 22).

128. **Pohlia Rothii** (Correns) Broth.

Pohlia annotina (L.) Lindb.

N. Iceland: Husavik ♂!; Stadr near Hrutafjördur!.

It was growing in both places on damp sandy soil, associated with *Dicranella crispa, Aongstrœmia longipes* and *Hepaticæ*. The gemmæ, which occurred only few in number, were quite typical.

Webera annotina Hedw. is recorded from the peninsulas of NW. Iceland (Stp.) and from Hafnarfjördur (Grl.), but as the collections con-

tain no specimens from these localities it cannot be decided which species is meant.

129. **Pohlia tenuifolia** (Schimp.).

Webera bulbifera Warnst.

E. Iceland: Hamarfjördur!; Berufjördur!; Seydisfjördur!. N. Iceland: Geitaskard!; Hnausar!. W. Iceland: Reykjavik! ♂.

P. tenuifolia is the most frequent of the small gemmiferous species of *Pohlia*. It usually grows on damp sandy soil, and often very abundantly, always bearing the characteristic gemmæ. Near Geitaskard it covered in company with species of *Bryum* the bottom of a dried up lake.

The leaves in all the Iceland plants are very longly decurrent.

130. **Pohlia grandiflora** H. Lindberg.

S. Iceland: Reykir!; Laugarvatn! ♂; Barkarstadr!; Midskálagil near Holt!; cave near Steinafjall!.

Near Reykir it was growing on the ground along a stream, associated with *Dicranella crispa*, *Pogonatum urnigerum*, *Scapania curta* and *Lophocolea minor*. Near Laugarvatn it was found abundantly on a warm clayey flat, associated with *Aongstrœmia longipes*, *Gymnocolea inflata* and a small sterile *Philonotis*. ♂ flowers were very numerous, but gemmæ were absent. In the other places it was found on faces of tuff rocks, associated with *Bartramia ityphylla*, *Pohlia cruda*, *Didymodon rubellus* and *Distichium montanum*. The gemmæ were quite typical in all these species.

Pohlia tenuifolia is an excellent species, easily known, even when gemmæ are absent, by the strong sheen and the narrow, longly decurrent leaves, in the upper half of which the cells are very narrow and often wavy.

131. **Pohlia proligera** Lindb.

N. Iceland: Vidimýri!.

It grew here rather scantily on damp sandy ground along a stream, bearing typical gemmæ.

132. **Mniobryum albicans** (Wahlb.) Limpr.

Pohlia albicans Lindb.

Very common.

Var. ***glacialis*** (Schleich.) Limpr.

Very common.

Both the type and the variety are the most common mosses everywhere on damp ground. The type grows on the ground along streams.

in bogs and on damp rocks. Var. *glacialis* grows always in cold water, especially in moss bogs. where in company with *Philonotis* it usually forms the bulk of the vegetation. In the Alpine region *Pohlia albicans* occurs abundantly, even at a height of about 600 metres. There it grows especially in and along watercourses, often filling up their — during summer — dried up beds by growing in large cushions both on the ground and on stones. As in *P. commutata*, the Alpine forms become more compact, with shorter, concave, appressed leaves and looser cell-tissue. Such forms have been found, for instance, near Dýrafjördur at an altitude of 300—400 metres, Esja at an altitude of about 500—600 metres and near Seljaland at an altitude of about 500 metres. Fruit occurs rather rarely, and in the type, as a rule, in a small quantity only. Fruiting specimens of the type were collected near Akureyri (ripe July 22), Holt (ripe July 19) and Breiddal (hardly ripe June 19). Var. *glacialis* was collected in fruit near Eyjafjördur (O. D.) and near Kaldalon in NW. Iceland, where the plant grew abundantly on inundated ground along small streams, and was often covered with fruit which was not quite ripe at the end of June.

133. **Bryum purpurascens** (R. Br.) Br. eur.

E. Iceland: Seydisfjördur!, common; Vallanes! (H. J.). N. Iceland: Mývatn (Grl.)!; Akureyri!, common; Husavik!, common. NW. Iceland: common about Isafjördur and Jökulsfjördur!. W. Iceland: Reykholtdalur (Grl.)!; Nordredalur!; Grimstunga (Grl.)!; Bardshellir (Grl.)!. S. Iceland: Traustholtsholm in the Thjorsá (F.)!.

Grows on damp peaty or sandy soil, especially near the coast. It occurs abundantly chiefly in places where the peat has been pared off. Near Seydisfjördur it was collected up to a height of about 400 metres. The fruit ripens in the beginning of August.

Bryum purpurascens varies rather considerably in the form of the capsule and in the structure of the peristome. The capsule is usually symmetrical, sometimes slightly asymmetrical, and then reminds one of *B. uliginosum*, from which it is, however, easily distinguishable by the large lid. The base of the peristome teeth (fundus) is often large and reddish yellow, and in the majority of the plants which have been investigated the lamellæ are sinuose in the middle, sometimes as strongly so as in *Bryum lapponicum*. The dorsal transverse segments are more or less distinctly transversely striated. The spores vary somewhat in size, from 0.024—0.035 mm.

It is a peculiarity with this species that the capsule, on being cut through and warmed in diluted ammoniacal water, imparts to the latter a substance which is intensely, but temporarily coloured red by the oxygen in the air. The same is often the case also with *B. uliginosum*. In the course of time the old capsules turn almost black in colour.

134. **Bryum lacustre** Blandow.

E. Iceland: Berufjördur!; Vallanes (H. J.;!). N. Iceland: Common near Husavik!; common near Eyjafjördur (O. D.;!); Saudanes (St.)!; Svinadalur!;

NW. Iceland: Bildudalr C. H. !. W. Iceland: Lundur!. S. Iceland: Traustholtsholm in the Thjorsá (F.)!; Breidabolstadr!.

Rather common, especially in N. and E. Iceland. It grows on damp sandy or peaty soil, especially in places where the peat has been pared off, and by the sides of ditches. Near Husavik it was growing plentifully on damp slopes stretching down towards the sea, in association with *Leptobryum, Aongstrœmia, Bryum inclinatum*, etc. Near Lundur it was growing in company with *Dichodontium, Aongstrœmia, Dicranella Schreberi* and *Bryum inclinatum* on peaty flats which had been pared off. The fruit was ripe near Berufjördur on June 20th, near Breidabolstadr on July 16th.

135. **Bryum Kaurini** Philib.

E. Iceland: Berufjördur (Grl.)!.

The specimens, which are quite typical, were gathered with ripe fruit on July 6th, 1878, and determined by Berggren as *B. inclinatum*

136. **Bryum archangelicum** Br. eur.

NW. Iceland: Hesteyri!. W. Iceland: Esja (Grl.)!; Brjanslækur H. J.)!. S. Iceland: Drángshlid (H. J.)!.

Both rare and scanty on rather dry, sandy ground or on soil-covered rocks. The fruit ripens at the end of July.

137. **Bryum Jörgensenii** Kaurin.

SW. Iceland: Thingvellir!.

The Iceland plant agrees exactly with *B. archangelicum* in habit. The leaves are narrowly and indistinctly bordered; the perichætial leaves have their margins revolute to the apex. The plants are often purely ♀; usually, however, a few antheridia and many archegonia are present. In none of the plants investigated did the lamellæ show the slightest sinuosity. The spores, which were yellow and almost smooth, were of very much the same size as in *B. archangelicum*.

138. **Bryum inclinatum** (Sw.) Br. eur.

Very common everywhere on a more or less damp substratum, on peat, sand and gravel, on soil-covered rocks, and in rock-clefts. It does not appear to ascend higher than about 300—400 metres above sea-level.

Bryum inclinatum varies so considerably in all its parts, in habit and size, in the length of the setæ, in the form and degree of inclination of the capsule, in the structure of the peristome, the size of the spores and in the form and cell-tissue of the leaf, that it is hardly possible to collect two tufts which do not show diversities in one respect or another. Perhaps on a closer investigation many of the forms might possibly be referred to some of the numerous "small species" established by

Hagen, Bryhn, Ryan, Arnell, Limpricht and other authors, or might with as great justice be described as new species. But without comparison with original specimens, and only according to the descriptions, it is impossible to form any opinion of the value of these species, which have very often been collected only in small quantity, and from a single locality, and which will therefore in many cases prove to be maintainable only so long as there does not exist more than the one specimen. It is very probable that it will not even be possible to maintain as varieties a great many of these forms which have been given specific rank, the characters used for separating the species being so variable that, on having abundant material for investigation, it is impossible to draw any boundary line between the forms. Here, only thorough investigations made at the habitat will be able to throw some light on the influence of the external conditions on the specific characters.

The height of the tufts and the length of the stems vary according to the degree of dampness, so that plants from dry and exposed habitats are low in growth with close-set leaves, and from damp localities, as a rule, higher, with elongated stems and more distant leaves. Also in places, slightly illuminated, for instance among grass and *Carex*-tufts, do the plants become higher with elongated stems. The leaves in *Bryum inclinatum*, in contradistinction to those in several other species of the same group, are stated to be not decurrent. This feature appears, however, to vary considerably, and to be closely connected with the habit of the plant, forms with short stems having close-set, not decurrent leaves, while the leaves on elongated stems are, as a rule, more or less decurrent. In such forms the uppermost close-set leaves have almost always a rounded, not decurrent base, while the leaves further down on the stem become more strongly decurrent the further they occur apart from one another. The form of the cells of the basal angles of the leaf also vary greatly according to the position of the leaf on the stem. The not decurrent leaves have a rounded base with quadrate, somewhat widened and thin-walled cells, but as the leaves downwards become more and more decurrent, the cell-form becomes elongate rectangular. The leaf-form varies from narrow-lanceolate to almost ovate, with a shorter or longer point. The lower leaves are usually shorter and broader, and the nerve vanishes just below the apex. The leaf-margin is revolute to the apex, more rarely it is plane in the upper part. The form of the leaf-cells is partly dependent on the leaf-form, long, narrow leaves having elongated cells, while broad, short leaves have broader cells, and even in leaves of the same plant the cell-form may vary considerably. The cell-walls vary somewhat in thickness. Xerophilous forms have often thick cell-walls, while bog-forms with large, broad leaves have thin-walled cells. The capsule varies in form from obovate to elongate-ovate. The neck of the capsule is usually straight, more rarely slightly curved.

The peristome teeth vary in colour from pale yellow to brownish yellow, being very strongly coloured where inserted. The "insertion" may be very differently developed, all transitions are met with, from a slightly indicated yellowish-brown or orange ring at the base of the peristome teeth to a highly developed compact thickening (fundus,

which may be almost as large as, for instance, that in *B. retusum*. It is, however, not usual for the thickening to be distinctly localized around the base of each individual peristome tooth; it has more the character of a continuous ring, 0.02—0.07 mm. broad. Hagen (Musci Norv. Borealis, p. 141) pronounces the opinion that ultimately all the species with a distinct fundus will be united together in a separate group in a natural system of species of *Bryum (Brya hæmotostomata)*. The feature in question appears, however, to be too variable for that purpose. It is especially in the group of forms of *inclinatum* that this peculiar development of the peristome base occurs, but it is also met with in other groups, although less frequently, for instance in *B. purpurascens* (where it may be almost as large as in *Brya hæmotostomata* Hagen) and in *B. uliginosum*. *B. curvatum* Kaur. & Arnell, which Hagen refers to *B. hæmatostomata*, also belongs to the *purpurascens pallens* group. On the other hand, forms may also be met with in which the fundus is rather slightly developed or even quite wanting, for instance *B. Kaurini*, *B. retusum* and *B. Graefianum*, referred by Hagen to *B. hæmatostomata*. This diminishes the value of the character in question, and it does not appear to have greater systematic importance than has the peculiar structure of the lamellæ for the group *Hemisynapsium*, which structure is especially met with in the group of species in which the fundus formation occurs. Both the fundus formation and the indentation of the lamellæ, as also the occurrence of perforations in the median line of the peristome teeth, are probably connected with certain external influences, and are very often met with together. Here it is especially the degree of salinity of the substratum which is of importance, aulacodonte peristomes being found almost exclusively in *Bryum* forms collected from localities close to the coast, while forms with a distinct fundus-formation, although most frequent in the vicinity of the sea, yet have also been found far inland, or at a height of 400—500 metres above sea-level. In Iceland indented lamellæ and peristome teeth more or less perforated in the median line have been observed in forms of *B. inclinatum*, *B. retusum*, *B. archangelicum*, *B. calophyllum* and *B. purpurascens*, in the last-mentioned species, however, the peristome teeth are never perforated.

The spores vary somewhat in size, most frequently 0.022—0.025 mm., more rarely as much as 0.029 mm.

Bryum lapponicum Kaurin has not been found in Iceland, but forms which approach this species by having broader and longly decurrent leaves are rather frequent.

139. **Bryum retusum** Hagen.

N. Iceland: Hnausar in Vatnsdalur!; Vidimyri!; W. Iceland: Stykkisholmur!; Borgarnes!.

This species grows on peat or soil-covered rocks. The capsules ripen in the beginning of July. Near Stykkisholmur they were almost ripe on June 15th. In all the plants referred to this species the leaves were shorter and broader than in *B. inclinatum*, with the nerve vanishing in the apex and shortly excurrent in the perichætial leaves. The capsule

is narrower than in *Bryum inclinatum*, not-glossy, dark brown, finely pitted (in *B. inclinatum* smooth and glossy), with a high and conical lid. The peristome teeth are narrow, dark yellow, with a very large, red fundus which is very easily loosened from the mouth of the capsule and falls off together with the peristome tooth belonging to it, equally wide to the middle or gradually tapering from the base, and very differently formed in the same peristome. Lamellæ 12—18 in number, very differently developed even in the same peristome, straight or sinuous, frequently also porous in the median line af the teeth. The spores vary somewhat in size, from 0.020 mm. (Borgarnes) to 0.024—30 mm. (Vidimýri).



Fig. 2. *Bryum islandicum* (× 2).

140. **Bryum islandicum** n. sp.

Cæspites densi ad 5—6 mm. alti. Caulis ruber, fragilis, valde tomentosus, innovationibus brevibus, numerosis.

Folia caulina inferiora decurrentia, 1.5 mm. longa et 0.7—0.9 mm. lata, superiora non vel vix decurrentia, ovata, longius cuspidata, apicem versus parce denticulata, 2—2.2 mm. longa et 0.75 mm. lata, ad basin rubra; margine tota longitudine reflexa, seriebus 3—4 cellularum angustiorum limbata. Cellulæ leptodermes paulum porosæ, basilares rectangulæ, 0.03—0.04 mm. longæ et 0.02 mm. latæ, ceteræ elongato hexagonæ, 0.03—0.04 mm. longæ et 0.015—0.018 mm. lata. Costa ad insertionem rubra, in aristam longam excurrens.

Folia perichætialia intima anguste lanceolata, vix limbata, costa excurrente longiuscule cuspidata.

Inflorescentia synoica; antheridia et archegonia numerosa.

Seta ad 15—20 mm. longa et 0.16 mm. crassa, rubra.

Capsula pendula, deoperculata ca. 3 mm. longa et 1 mm. crassa, opaca fusca leptodermis, sicca leviter rugulosa. Operculum humile conicum. Annulus latus. Cellulæ exothecii leptodermes, marginales in series 3—4 transverse rectangulæ-polygonæ quadratæ, ceteræ irregulares.

Exostomii dentes e fundo fusco-aurantio 0.4 mm. longi et 0.065 mm. lati, fusco-aurantii apice lutei, anguste limbati, subtiliter punctulati. Lamellæ 14—16, inter se liberæ, marginibus integris. Endostomium exostomio haud connatum, luteolum, parce papillulosum; processibus lanceolatis, in carina ovaliter fenestratis, ciliis pro more rudimentariis.

Sporæ 0.039—0.038 mm. diam. olivaceæ, punctulatæ.

N. Iceland: Akureyri, on damp ground at an altitude of about 300 metres, July 20th, 1909.

141. **Bryum calophyllum** R. Brown.

E. Iceland: Vallanes!, on wet boggy ground. The capsules were quite green even on June 27th.

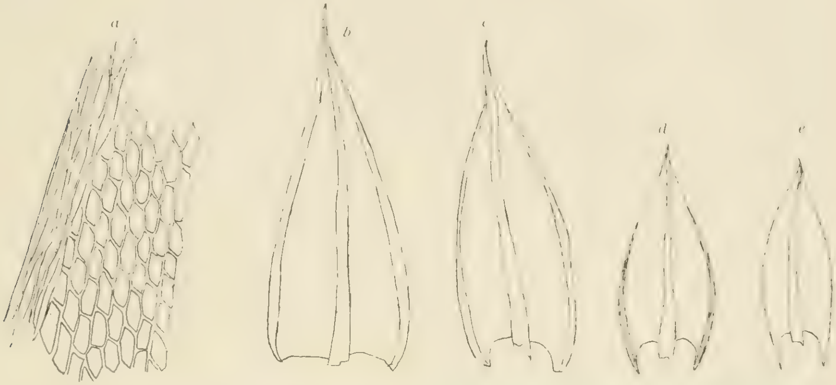


Fig. 3. *Bryum islandicum.* *a*, Leaf margin (× 120); *b* and *c*, perichætial leaves; *d* and *e*, leaves.

142. **Bryum uliginosum** (Bruch) Br. eur.

N. Iceland: Husavik!; Svinadalur!. W. Iceland: Haukadalsheidi!, at an altitude of about 300 metres.

In all the above localities it grew abundantly on damp, sandy ground. On Haukadalsheidi the fruit was ripe on Aug. 1st, in the other localities it was unripe in the middle of July.

Besides ♂ and ♀ flowers, a few hermaphrodite flowers also occur frequently. The papillæ of the peristome are in the lowermost transverse segments often distinctly arranged in transverse rows, and sometimes there are also distinct transverse bars as in *B. purpurascens*. As is the case in the latter species, the ripe capsule contains a colouring matter which on being treated with ammonia assumes a red colour in the air.

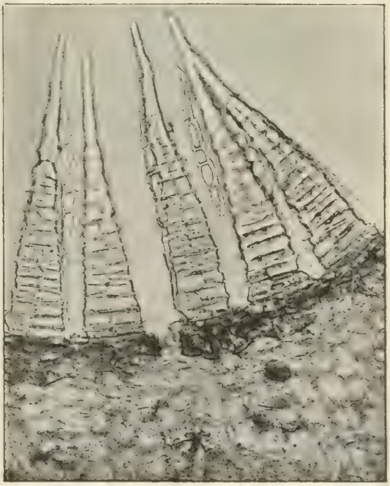


Fig. 4. *Bryum islandicum.* Peristome (× 120; phot.).

143. **Bryum Grœnlundii** n. sp.

Cæspites laxiusculi, ca. 1.2 cm. alti, superne virides, subnitentes; surculi innovationes tenues.

Folia caulina decurrentia, inferiora ovata, breviter cuspidata, superiora longius cuspidata, breviter vel non decurrentia, 2.3 mm. longa et 0.9—1 mm. lata, apice integra vel leviter dentata; margine ad apicem reflexa, seriebus 2—4 cellularum angustiorum limbata. Cellulæ foliares leptodermes, indistincte porosæ, basilares rectangulæ, 0.035—0.050 mm. longæ et 0.018—0.020 mm. latæ, ad insertionem rubræ; illæ folii medii elongato-hexagonæ, vel rhomboideæ 0.05—0.08 mm. longæ et 0.015—0.018 mm. latæ, apicales angustiores. Costa fusco-lutea, ad insertionem 0.08 mm. lata, in foliis inferioribus sub apice desinens, in superioribus in cuspidem integram excurrens.



Fig. 5. *Bryum Grœnlundii* (× 3).

Folia perichætialia intima anguste triangula, margine limbata.

Inflorescentia synoica; antheridia perpauca; archegonia et paraphyses numerosæ, roseæ.

Seta 3—4 cm. longa et 0.20 mm. crassa, rubra.

Capsula nutans, arcuato-clavata deoperculata 3.35 mm. longa et 1 mm. crassa, sub orificio obliquo rubra contracta; collum 1.5 mm. longa. Operculum humile conicum, apice rubro. Annulus 0.14 mm. latus, triplex. Exostomii dentes e fundo purpureo vel rubro-aurantio bene definito 0.40—0.45 mm. longi et 0.10 mm. lati, fusco-lutei, anguste limbati, dense et subtiliter papillulosi; lamellæ ca. 24, inter se liberæ, margine integra. Endostomium exostomia vix adhærens, luteum, subtiliter papillulosum; processus dentibus æquilongi, fenestrati; Cilia nulla. Sporæ olivaceæ, 0.025—0.033 mm. diametro, punctulatæ.

W. Iceland: Haukadalsheidi on damp gravelly ground at an altitude of about 350 metres, August 1st, 1909.

144. **Bryum fallax** Milde.

N. Iceland: Geitaskard!, fr.

It was growing here in a dried up pool among *Pohlia tenuifolia.*

145. **Bryum œneum** Blytt.

Bryum rutilans Brid.

E. Iceland: Djupivogur!; Seydisfjördur!; at an altitude of 400 metres. N. Iceland: Akureyri!, at an altitude of 350 metres. NW. Iceland: Bildu-

dalur (C. Hansen)!. NW. Iceland: Lundur!, fr. S. Iceland: Vestmannaey!; fr.; Skálholt!; Austerhlid near Geysir!; Breidabolstadr!; Barkarstadr!; Holt!, fr.; Dránsghlid!.

Common in the southern part of the country and on Vestmannaey; rarer in the other parts of the country. In S. Iceland it grew especially

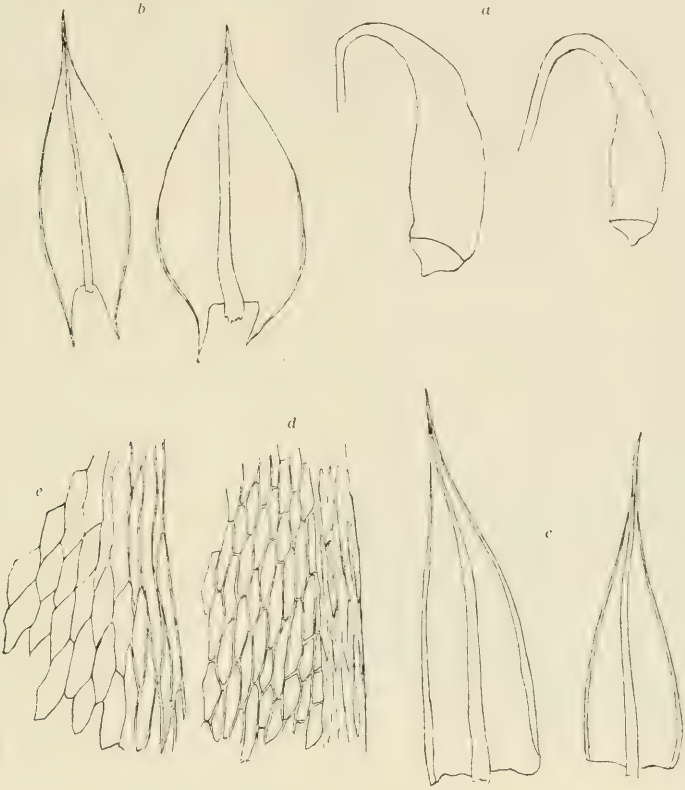


Fig. 6. *Bryum Grœnlundii.* *a*, Capsules (× 20); *b*, leaves (× 20); *c*, perichætial leaves (× 20); *d*, leaf margin at base, and *e*, from the middle of the leaf (× 120).

abundantly everywhere in clefts of tuff rocks, and on Vestmannaey it was also frequent on the faces of damp tuff rocks. It was found in several localities in fruit, which was quite green even in the beginning of July. Near Lundur it was found on damp ground, associated with other *Bryum* spp. and *Dichodontium*, and had ripe fruit at the end of July. In several of the fruiting specimens from this locality a few hermaphrodite flowers were found besides the numerous ♀ flowers. ♀ plants occur everywhere, but ♂ plants have not been found.

In the leaf-angles of all the plants investigated hair-formations were found, consisting of readily falling, 8—10 celled, brown, papillose hairs, which very easily break into pieces of 2—4 cells. The leaves vary from shortly pointed, with nerve vanishing just below the apex, and shortly

rhomboid, equilateral-hexagonal or almost quadrate cells (forms from Akureyri), to more or less longly pointed, with excurrent nerve, and narrower, rhomboid or elongate-hexagonal cells.

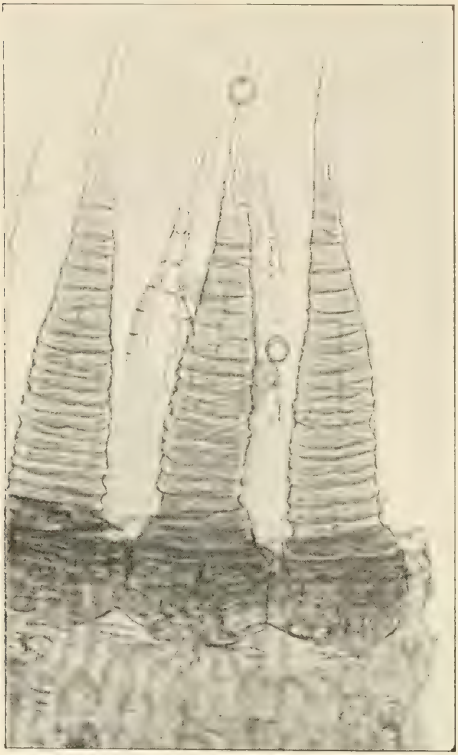


Fig. 7. *Bryum Grœnlundii.* Peristome (× 250; phot.).

146. **Bryum bimum** Schreb.

E. Iceland: Vallanes.

It has been collected only scantily on damp ground, with capsules which were not ripe at the end of June.

Two sterile *Brya*, collected by Helgi Jónsson near Stöd in E. Iceland and in Budahraun, are referred to this species by C. Jensen. The leaves in both the plants taper to a long point, are longly decurrent, have narrow basal cells, and the nerve excurrent; therefore, the plants probably belong to *Bryum affine*, but owing to the absence of fruit the determination is quite uncertain.

147. **Bryum affine** (Bruch) Lindb.

Bryum cuspidatum Schimp.

Commonly distributed.

One of the most frequent species of *Bryum*, and occurs everywhere in the lowlands on damp sandy or peaty ground, and on humus-covered rocks. The fruit ripens in the first half of July. It varies exceedingly in all its parts. It is said to differ from the very nearly allied *B. cirratum* in its sex, the smaller, smooth spores, and the decurrent leaves with the broader cells; but all these features are so variable that in reality it is hardly possible, at least in the Arctic countries, to separate these two species.

The plant is usually synoicous, but ♂ flowers are also almost always present; ♀ flowers are more rare. The spores vary in size from 0.008 to 0.020 mm., and often differ rather considerably in size in the same capsule, or in different capsules from the same tuft; the most frequent size is 0.012—0.017 mm.; they are sometimes smooth, sometimes finely papillose. The leaves vary in form from about ovate to lanceolate, tapering more or less to a long point, and with the nerve longly excurrent. In form the leaf-cells correspond nearly with the leaf, so that short leaves have broader cells than have those which are long and narrow.

The leaf-base, at any rate in the lower leaves, is decurrent, with elongated, narrow alar cells. The close-set uppermost leaves are usually not decurrent, and then have the base rounded, with quadrate, somewhat widened alar cells.

The structure of the leaf-base evidently depends on the degree of dampness of the habitat. *Bryum cuspidatum* usually grows on boggy ground and forms here tufts, 1—3 cm. high, with rather long innovations. On such elongated shoots the leaves are always decurrent. On a more dry and exposed substratum, for instance on rocks, the tufts become lower in growth and denser, and then the leaves are only slightly, or not at all, decurrent, and in connection with this the alar cells are short as in *Bryum cirratum*.

148. **Bryum cirratum** Hoppe et Hornsch.

Rather common.

Grows in drier localities than does *B. affine*, for instance in gravelly soil, on slopes and among grass. It is especially common in NW. Iceland, and occurred abundantly for instance on stony slopes near Dýrafjördur.

The forms which are here referred to *B. cirratum* have ⚥, ♀ and numerous ♂ flowers. The leaves are not decurrent, taper to a very long point, with narrow, almost linear cells in the upper portion. The spores are 0.014—0.020 mm., yellow, and finely papillose. *Bryum affine* and *B. cirratum* form a continuous series of forms, in which *B. affine* represents the hygrophilous and *B. cirratum* the xerophilous adaptation-form.

149. **Bryum intermedium** (Ludw.) Brid.

N. Iceland: Grimsey (O. D.)!; Vidimýri!; Stadr near Hrutafjördur!. S. Iceland: Merkjáfoss (F.)!.

Rather rare and scanty on damp soil. Near Stadr the fruit was ripe on August 1st, but the lid still persisted.

150. **Bryum pallescens** Schleich.

Widely distributed.

One of the most frequent species everywhere up to a height of about 300 metres above sea-level. It usually grows on damp rocks, where it often forms very large and deep cushions, with numerous capsules; but it also occurs on damp soil. In South Iceland it is very common everywhere on faces of tuff rocks. The plant is, as a rule, monoicous, but very often hermaphrodite flowers are also met with, containing many antheridia and a few archegonia.

151. **Bryum subrotundum** Brid.

S. Iceland: Uxavatn (F.)!.

152. **Bryum capillare** L.

E. Iceland: Hamarfjördur!. N. Iceland: Mödrufellshraun (St.)!; Grimsey (O. D.)!. W. Iceland: Hvammur (Grl.)!; Hafnarfjördur!; Videy!, several places near Reykjavik!. S. Iceland: Breidabolstadr!; Holt!. Vestmannaey!.

This species occurs, as a rule only sparingly, on humus-covered rocks and in lava-clefts. Only on Vestmannaey was it common, occurring especially on the tumbled-down blocks at the foot of cliffs inhabited by sea-fowl.

The nerve usually vanishes just below the hair-shaped leaf-point. In the plant from Mödrufellshraun and in the majority of the specimens from Vestmannaey the nerve varied considerably in length, sometimes reaching scarcely beyond the middle of the leaf, sometimes almost to the apex. The plants from the former habitat, in addition, bore clusters of easily falling brown threads in the uppermost leaf-angles, quite similar in appearance to those in *Bryum æneum*.

153. **Bryum cæspiticium** L.

Iceland (Krabbe, 1863)!. E. Iceland: Seydisfjördur!; Vallanes (H. J.; !); Hallormstadaskogur!. N. Iceland: Hálsskogur!; Stadartunga (O. D.)!; Vidvik (P. Sofóniasson)!. S. Iceland: Almannagjá!.

Grönlund records this species from Reykjavik and Laugardalur, but there are no specimens of it from these localities in the collections.

Grows in dry sandy soil, especially in birch coppices, and appears to be rather frequent in North and East Iceland. It occurred abundantly in several localities in Hálsskogur. Near Vallanes it occurred sometimes on dry sandy soil, sometimes on the dikes and peat-walls of the farm. In Hálsskogur the fruit was ripe on July 19th, but some of the lids still persisted.

154. **Bryum comense** Schimp.

N. Iceland: Reistarárgil (O. D.)! ♀; Hof (St.)!.

Both the above localities are situated on the east side of Eyjafjördur.

155. **Bryum elegans** N. v. Es.

E. Iceland: Djupivogur! ♂; Berufjördur (Grl.)!. N. Iceland: Reykjahlid! ♂. NW. Iceland: Isafjardarheidi, at an altitude of 450 metres! ♂ and ♀. W. Iceland: Hafnarfjördur!; Svinahraun!. Vestmannaey!.

Not common, but sometimes abundant in humus-filled rock and lava clefts, etc. Near Reykjahlid it was common in the lava-field.

Varies considerably in leaf-form, the length of the nerve, etc. The plant from Isafjördur has distinctly bordered, erect spreading, and narrower leaves, and belongs most nearly to var. *carinthiaca* (Br. eur.) Breidl. In lava-clefts there usually occurs a low, compact form with

concave, adpressed, and not bordered leaves, with loose cell-tissue and not excurrent nerve, which agrees most closely with var. *Ferchelii* (Funck) Breidl.

156. **Bryum argenteum** L.

Commonly distributed.

This species has been found only in the lowlands, where it is especially frequent around inhabited localities. It grows there on the peat walls of the houses, on the dikes and on the ground in the neighbourhood of the dwelling houses, and prefers, on the whole, a well-manured substratum. It is also common near the sea-side, both on sandy soil and upon stones, and occurs especially abundantly below cliffs inhabited by sea-fowl, for instance on Vestmannaey.

157. **Bryum Neodamense** Itzigs.

Var. *ovata* (Jur.) Lindb. et Arnell.

E. Iceland: Seydisfjördur!, sterile.

It was growing here in cushions about 6 cm. high, in water in a stream, at an altitude of about 100 metres.

158. **Bryum Duvalii** Voit.

Very common.

Grows everywhere on very wet ground or in water, especially in moss bogs or along the banks of streams, where it often forms large vinous red cushions in the light green patches of *Philonotis*, *Bryum ventricosum* and *Mniobryum albicans*. As a rule it does not ascend higher than 300—400 metres. Near Barkarstadr in S. Iceland it was found at an altitude of 500 metres. The fruit, which ripens in the middle of July, is rare, and has been found only rather scantily near Berufjördur, Ljosavatn and Tverá in Øxnadalur.

159. **Bryum pallens** Sw.

Widely distributed.

Grows on a damp substratum, both on soil and on rocks. In S. Iceland it is very common on faces of damp tuff rocks. It grows especially on the marginal strip of soil and on the slopes along streams, in small reddish tufts, associated with *Dichodontium*, *Philonotis* and *Dicranella crispa*, but it is very often sterile. On the promontory near Reykjavik it grew in enormous quantities on damp peaty ground, with masses of capsules which, in the first week of August, were ripe, but the lids were not yet thrown off.

It is only by exception that *Bryum pallens* ascends higher than about 300 metres above sea-level. Near Berufjördur it has been collected at an altitude of about 500 metres.

Note. *Bryum turbinatum* is recorded from Iceland by Mörch, Hornemann and Grönlund, but all the specimens in the collections are wrongly determined.

160. **Bryum ventricosum** Dicks.

Very common.

One of the most frequent mosses, which occurs in numerous forms everywhere on a damp substratum, both on soil and on rocks. In water, for instance in moss bogs and along the banks of streams, it forms extensive, light green mats. The plants are only slightly tomentose, with large, spreading leaves, and thin-walled cells. In bogs, where it occurs everywhere in abundance, it is sometimes low in growth, sometimes as much as 6—7 cm. high, and often richly fruiting. Forms from a more dry substratum, for instance from rocky clefts, are low in growth and densely tomentose. It is common upwards of 600 metres above sea-level.

161. **Bryum arcticum** (R. Br.) Br. eur.

This species is widely distributed over the whole of Iceland, but occurs, as a rule, rather sparingly.

It grows on peat, on damp sandy soil and on humus-covered rocks, usually mixed with other *Brya*, and hardly ascends higher than 200—300 metres. The fruit ripens at the end of July.

It varies rather considerably. The capsule is sometimes short and inflated, sometimes more slender. The spores vary from 0.020—0.035 mm. The lamellæ are usually connected by one or two transverse bars. Near Seydisfjördur a form has been collected with a partly aulacodont peristome and very few transverse bars.

162. **Bryum pendulum** (Hornsch.) Schimp.

N. Iceland: Hof (O. D.)!. W. Iceland: Reykjavik!; Reykholtdalur!. S. Iceland: Gilfoss (F.)!; Barkarstadr!; Breidabolstadr!. Vestmannaey!. In previous lists some more habitats have been enumerated for this species (Grl.; H. J.), but they are all due to confusion with other species, mostly with *B. arcticum*.

Bryum pendulum appears to be rather rare and, as a rule, has been found only in small quantity mixed with other *Bryum* spp. on damp sandy soil or on damp tuff rocks. Fruit ripens in the beginning of August.

As in *Bryum inclinatum* the base of the peristome may be rather differently developed. Thus, in a specimen from Breidabolstadr, a rather large reddish-yellow thickening had been developed which could be loosened from the mouth of the peristome together with the peristome tooth belonging to it, as in the species of Hagen's *Brya hæmatostoma*.

One of the specimens from Hof, collected by O. Davidson, was monoicous, but was otherwise quite typical.

163. **Bryum Brownii** Br. eur.

N. Iceland: Hof (O. D.)!. W. Iceland: Reykjavik!.

On the peninsula near Reykjavik it occurred abundantly on damp sandy ground in company with *Bryum pallens* and *B. inclinatum*. Fruit was ripe on August 5th.

It is also recorded from several localities which are enumerated in Grönlund's lists, but all the corresponding specimens in the collections are wrongly determined.

164. **Mnium hornum** L.

Astrophyllum hornum Lindb.

E. Iceland: Common from Hornafjördur to Berufjördur!; Seydisfjördur!; Vallanes (H. J.)!. N. Iceland: Akureyri!; Hof near Eyjafjördur (O. D.)!; Geitaskard!; Vatnsdalur!. NW. Iceland: Common everywhere about Isafjördur!; Bildudalr (C. H.)!; Dyrafjördur!; near Jökulsfjördur!. W. Iceland: common everywhere (Grl.; H. J.;!). S. Iceland: Common!. Vestmannaey!.

Common in East, South, West and North-west Iceland, rarer northwards. It occurred abundantly even in Vatnsdal and Blónddal (Geitaskard), but further eastwards it was collected only in a few localities near Eyjafjördur. It appears to be quite absent, for instance, from the district around Husavik. It grows almost exclusively on somewhat damp, peaty ground, especially on knolls or along the sides of ditches, more rarely on soil-covered rocks. ♀ plants occur rather frequently; on the other hand, it has not been found in fruit.

165. **Mnium orthorrhynchum** Brid.

Astrophyllum orthorrhynchum Lindb.

Very common everywhere in soil-filled rock-clefts, and ravines, on faces of damp tuff rocks, etc., and occurs in wide-spread unmixed tufts or more often mixed with other mosses. ♂ flowers are rather common; on the other hand, it has not been collected in fruit. It does not appear to ascend higher than 400—500 metres above sea-level.

166. **Mnium serratum** Schrad.

Astrophyllum marginatum (Dicks.) Lindb.

N. Iceland: Hof near Eyjafjördur (O. D.)!. Vidvik (P. Sofóniasson)!. W. Iceland: Giljárfoss and Kleppjarnsreykir in Reykholtsdalur (Grl.)!; Kalmanstunga (Grl.)!; Fell near Kollafjördur (St.)!; Álafoss!. S Iceland: Flokastadagil!; Barkarstadr!; Holt!; Austarhlid near Geysir!. Vestmannaey!.

It grows on damp, shady rock-sides in caves and clefts in the lowlands, and is rather common in the southern part of the country.

where it often occurs abundantly in the clefts of tuff rocks. In West Iceland it is met with here and there, while it is rare in North Iceland and has not yet been found in East Iceland. The fruit, which is found everywhere, ripens in the first half of June.

167. **Mnium spinosum** (Voit) Schwægr.

Astrophyllum spinosum Lindb.

N. Iceland: Ásbyrgi (St.)!; Hof near Eyjafjördur (O. D.)!; Akureyri!.

In all the above localities it was found on dry grass-covered ground growing among *Hylocomium proliferum*, *H. squarrosum*, *H. triquetrum*, *Hypnum uncinatum* and *Lophozia lycopodioides*. Near Akureyri it occurred, however, also on a somewhat damp slope (200 metres above sea-level), intermixed in a large tuft of *Mnium stellare*. Only ♀ flowers have been found.

168. **Mnium undulatum** (L.) Weiss.

Astrophyllum undulatum Lindb.

W. Iceland: Kollafjördur!, at an altitude of 100 metres. S. Iceland: Vik; Hnappavellir; Hjörleifshöfdi (H. J.)!; Reykir!; Breidabolstadr!; Barkarstadr!; Seljaland!; Holt!; Drángshlid!. Vestmannaey!.

This species has been found only in the south-western part of the country, where it is common on Flótshlid and along Eyjafjall. It was found in several places on Vestmannaey, for instance abundantly in Heljusdalur. It grows as a rule in damp soil at the foot of rock-walls and in clefts, especially in localities which are well protected and have a luxuriant grass-vegetation. It is also met with in damp caves, for instance near Reykir. Only sterile specimens have been found.

169. **Mnium cuspidatum** (L.) Leyss.

Astrophyllum silvaticum Lindb.

N. Iceland: Hof near Eyjafjördur (O. D.)!. S. Iceland: Holt!. Vestmannaey!.

Near Holt it grew at the bottom of and up on the sides of a small tuff-cave. On Vestmannaey it was found rather abundantly among grass on a somewhat damp slope.

Mnium cuspidatum is enumerated in Vahl's list, and has, moreover, been recorded from several localities by Grönlund, Stefansson and Helgi Jónsson. All these specimens are, however, wrongly determined, and the majority of them belong to *M. affine*.

170. **Mnium medium** Br. eur.

Astrophyllum medium Lindb.

SE. Iceland: Hornafjördur.

It grew here on boggy ground mixed with *M. affine* and *M. cinclidioides*.

171. **Mnium affine** Blandow.

Astrophyllum cuspidatum (L.) Lindb.

Very common.

This species grows both in bogs, where it occurs everywhere and almost always intermixed with other bog mosses, especially *Hypnaceæ*, *Cinclidium stygium* and *Mnium cinclidioides*, and on the ground among grass, as also on rocks. It is most frequent in the lowlands, and hardly ascends higher than 400—500 metres above sea-level. ♀ plants are very common; on the other hand it has not been collected in fruit.

It varies considerably in habit, leaf-tissue and serrature of the leaf-margin. In very wet localities the annual shoots become erect and the stems often highly tomentose (var. *elata* Lindb.). On a more dry substratum, especially on humus-covered rocks, the annual shoots are bent downwards in a curve, and are rooting at the apex, and the fertile shoots are quite short. The leaves are only very slightly or not at all decurrent. In the forms from a dry substratum the leaf-cells are rather thick-walled, distinctly porous, and often collenchymatous; in bog-forms they are more thin-walled and slightly porous. The teeth of the leaf-margin are usually unicellular and obtuse, more rarely 2—4-cellular; forms are very frequently met with in which the teeth are very slightly developed or almost quite wanting, so that all transitions to var. *integrifolia* Lindb. occur. The latter form is occasionally met with, especially on rocks.

172. **Mnium Seligeri** Jur.

Astrophyllum Seligeri (Jur.) Lindb.

E. Iceland: Hornafjördur!; Berufjördur!; Seydisfjördur!; Vallanes (H. J.)!. N. Iceland: Husavik!; Akureyri!; Ljosavatn!; Helgavatnsfloi (St.)!. W. Iceland: Stykkisholmur!. Very common in SW. Iceland!.

Grows on a very wet substratum, in marshes, moss bogs and along streams, and often very abundantly. ♀ plants are almost always met with; on the other hand, ♂ plants or plants in fruit have not been collected.

M. Seligeri is one of the mosses of most common occurrence in the south-western part of the country, from Hvalfjördur southwards, and also about Hornafjördur; it often forms the bulk of the vegetation, for instance in the great bogs in Ölfus. In E. Iceland it is rather common, and is also hardly rare in N. Iceland, but from NW. Iceland it appears to be quite absent. It is easily distinguished from *M. affine* by its broadly decurrent leaves, which are concave on the under surface. The leaf-cells are, as a rule, somewhat smaller than in *M. affine*, 0.04—0.07 mm., more thick-walled than in the latter species and decidedly collenchymatous; forms are, however, often found with thin-walled and somewhat larger cells, which are then hardly to be distinguished from *Mnium affine* v. *elatum* except by the decurrent leaves.

173. **Mnium stellare** Reich.

Astrophyllum stellare Lindb.

E. Iceland: Berufjördur!; Hof!. N. Iceland: Akureyri!, fr.; Tverá in Öxnadalur!. W. Iceland: Waterfall in Brynjudalur (Grl.)!. S. Iceland: Holt!; Vestmannaey!.

This species grows on damp soil, in rock-clefts, and on tuff, and as a rule sparingly. Near Akureyri it was found mixed with *M. spinosum* on a damp slope, and in fruit which was ripe on July 20th, but the capsules had not then thrown off their lids. Near Berufjördur it grew in the fissures in the basalt, mixed with *Pohlia cruda*, *Distichium montanum* and *Plagiothecium pulchellum*. In Heljusdalur on Vestmannaey it covered the vertical faces of large, tumbled-down blocks of tuff rock in company with *M. serratum* and *M. orthorrhynchum*.

174. **Mnium cinclidioides** (Blytt) Hüben.

Astrophyllum cinclidioides (Blytt) Lindb.

Very common over the whole of Iceland.

The most common species of *Mnium*. It is hardly absent from any bog, where it often forms the bulk of the vegetation, and it is also found everywhere in moss bogs and along the banks of streams. It is common even at a height of above 400 metres above sea-level, and occurs, for instance near Seydisfjördur and Akureyri, in bogs at an altitude of about 500 metres. ♀ plants are common, ♂ plants and fruit have not been found in Iceland.

175. **Mnium punctatum** (L.) Hedw.

Astrophyllum punctatum (L.) Lindb.

Very common all over Iceland.

Grows everywhere in damp localities, in marshes, where it often forms the bulk of the vegetation, in moss bogs, along the banks of streams, on wet rocks, by waterfalls, etc. It is most frequent in the lowlands up to 300—400 metres, but very often it ascends considerably higher, for instance in Svinaskard to about 500 metres above sea-level, and in Berufjardarskard to about 550 metres.

♀ plants are common; the fruit, which is frequently found, was overripe in the middle of June, and the capsules had thrown off their lids (E. Iceland).

176. **Mnium subglobosum** Br. eur.

Astrophyllum pseudopunctatum (B. S.) Lindb.

E. Iceland: Hornafjördur!, sterile. N. Iceland: Hof near Eyjafjördur (O. D.)!, fr.; Stadr near Hrutafjördur!, fr.; Mödruvellir (St.); Mývatn (Grl.)!, sterile. W. Iceland: Reykjavik!. The other habitats recorded by Grönlund belong to *Cinclidium stygium*.

This species is no doubt rather widely distributed, but often overlooked on account of its great resemblance to the far more frequently occurring *M. punctatum*. Like the latter it grows on wet boggy ground. Fruit was unripe both near Hornafjördur (June 11th) and near Stadr (July 29th).

177. **Cinclidium stygium** Sw.

Very common.

In East and North Iceland this species is one of the mosses of most common occurrence, and is found everywhere in bogs, where it is often the most abundant constituent of the vegetation. Here it grows by preference in the wettest parts, growing even in the shallow water on inundated ground or along streams, but it occurs also on more dry ground, and then usually mixed with other bog mosses, for instance, *Hypna*, *Mnia* and *Sphagna*. In the other parts of the country it is also common, although there it does not occur so abundantly; in South Iceland I have only observed it growing intermixed — as a rule scantily — with other bog mosses in, I think, every bog, but never in large growths. Near Akureyri it is frequent as far upwards as about 600 metres above sea-level, and in East Iceland, for instance near Berufjördur, it was collected up to a height of 550 metres. The fruit, which is common especially in North Iceland, ripens at the end of July.

Note. A small sterile plant, collected by Helgi Jónsson near Höfdi, was by C. Jensen referred with doubt to *Cinclidium subrotundum*, but a closer investigation has proved that it must be referred to *C. stygium*.

Fam. MEESEACEÆ.

178. **Paludella squarrosa** (L.) Brid.

This species has a similar distribution to that of *Cinclidium stygium*. It grows in bogs and is exceedingly common especially in N. Iceland, where it sometimes occurs mixed with other bog mosses, sometimes in large, pure cushions. It is also common in E. Iceland, at any rate from Berufjördur northwards, in NW. Iceland and in W. Iceland. In S. Iceland it is far more rare, and has not been found, for instance, on Fljótshlid or below Eyjafjall. It does not appear to ascend very much higher than about 400 metres above sea-level. Fruit was found only near Eyjafjördur.

179. **Amblyodon dealbatus** (Dicks.) P. Beauv.

N. Iceland: Hof near Eyjafjördur (O. D.)!, fr.

It was growing here scantily, intermixed in a tuft of *Distichium montanum*, *Ditrichum flexicaule*, *Myurella julacea*, etc.

180. **Meesea trichoides** (L.) Spruce.

Meesea uliginosa Hedw.

Very common.

This species grows especially on boggy ground, but is also frequent

on wet sandy or gravelly ground and on damp rocks. In the greater part of the country it is very common in such localities; only in NW. Iceland and partly in S. Iceland does it occur more scantily, for instance on Fljótshlid and below Eyjafjall. It is most frequent in the low land, but nevertheless often ascends up to a height of 500—600 metres above sea-level. The fruit, which is always present plentifully, ripens at the end of July.

181. **Meesea triquetra** (L.) Ångstr.

Meesea tristicha Br. eur.

Common in E. and N. Iceland!. NW. Iceland, Arngerdareyri!; W. Iceland: frequent about Reykjavik and Esja!; rarer and most scanty in S. Iceland.

It grows on boggy ground, sometimes in small unmixed tufts, sometimes intermixed with other mosses such as *Hypnaceæ, Paludella, Mnium affine*, etc. Only sterile specimens have been found.

182. **Catoscopium nigritum** (Hedw.) Brid.

Very common in E., N. and W. Iceland, more rare and rather scanty in NW. and S. Iceland. It grows on wet boggy ground, where it sometimes forms very dense tufts about 8—10 cm. high, sometimes grows interspersed in tufts of other mosses. It occasionally occurs so abundantly, especially in N. Iceland, that it may form the main part of the vegetation in the bogs.

Grönlund records that this species is one of the character-plants of the warm ground, and C. Jensen (Bot. Tid. XIV 1885) has described a var. *Grönlundii*: "filiformis, humilis, superne flavescens, inferne nigrescens. Folia subremota imbricata, minima, ovata lanceolata, integra vel subintegra, costa crassa in apicem evanida, cellulis minoribus, incrassatis et papillosis," which was collected by Grönlund near a hot spring in Reykholtdalur. In Grönlund's collections in the Botanical Museum in Copenhagen there are some mosses determined as *Catoscopium nigritum* or *C. nigritum* var. *Grönlundii* from a warm substratum. Of these only one specimen from Reykholtdalur belongs to var. *Grönlundii*, and I have collected similar forms rather scantily near other hot springs. This form differs only slightly from the type, chiefly only in being less tomentose and in having shorter leaves. Almost all the other specimens of *Catoscopium* collected by Grönlund were wrongly determined, as they belong to *Archidium phascoides*, and on the whole *Catoscopium* occurs only accidentally and scantily on a warm substratum.

The fruit, which occurs very frequently and plentifully, was in June-July either old and emptied from the previous year or yet quite unripe.

183. **Conostomum boreale** Swartz.

Conostomum tetragonum (Vill.) Lindb.

Widely distributed over the whole of Iceland.

In W. and S. Iceland this species is found only by exception at a

lower level than about 250 metres, and not until a height of about 400 metres and upwards is it common. In N. and E. Iceland it is also most frequent in the Alpine region, but grows, however, abundantly down to the low land in many places, for instance near Hof in the south-east. In NW. Iceland it is very common from the sea-level up to the snow-line.

It usually grows on dry and stony — more rarely damp — ground, most frequently on rocky flats, where it forms exceedingly dense and compact cushions, as much as 10 cm. deep, which occur wedged very firmly into the substratum. The cushions are, as a rule, interwoven with hepatics such as *Lophozia alpestris*, *L. ventricosa* v. *porphyroleuca*, *Pleuroclada albescens*, *Cephalozia pleniceps*, etc.

Like many other Alpine species *Conostomum* also occurs in the lava-fields, for instance abundantly in the clefts near Thingvalla; the tufts are here considerably looser and less tomentose than in the Alpine form. Fruit, which occurs everywhere, ripens in the first half of August.

Fam. AULACOMNIACEÆ.

184. **Aulacomnium palustre** (L.) Schwägr.

Sphærocephalus palustris (L.) Lindb.

Very common on damp boggy ground along the banks of streams, and on damp, soil-covered rocks. It occurs most abundantly on knolls in bogs, in company with species of *Sphagnum*, and among *Carices* in damp tracts of meadow land. Only sterile specimens have been found.

185. **Aulacomnium turgidum** (Wahlb.) Schwägr.

Sphærocephalus turgidus (Wahlb.) Lindb.

E. Iceland: Hof!; Seydisfjördur!; Skreiddal!; Berufjardarskard!, at an altitude of 540 metres; Djupivogur!. N. Iceland: Vatnsdalsfjall (St. !; Lækjarmot!, at an altitude of 350—450 metres; Akureyri!, at an altitude of about 900 metres. NW. Iceland: Grunnavik!, at an altitude of 260 metres; Armuli!, at an altitude of 150 metres. W. Iceland: Esja!, at an altitude of 420 metres. S. Iceland: Holt near Eyjafjall!; in several places from the low land up to 400 metres above sea-level.

This species is rather common especially in E. Iceland, in fact it may almost be called common there; for instance, near Hof in SE. Iceland it was very frequent and, in several localities, plentiful. It appears to be of almost equal frequency in the lowlands and on the mountain heights.

It grows especially on somewhat damp gravelly ground, more rarely on soil-covered rocks, associated with *Hylocomium*, *Rhacomitrium canescens*, *Dicranum congestum*, *Hypnum uncinatum*, etc. Near Hof it grew in great abundance along the river, on the gravelly flats covered with *Grimmia canescens*. Near Lækjarmot it was common as an intermixture in the *Rhacomitrium hypnoides* heath on the mountain slopes, about 350—400 metres above sea-level, and near Grunnavik it grew on damp rocks among other mosses. Only sterile specimens have been found.

Fam. BARTRAMIACEÆ.

186. **Bartramia ityphylla** (Haller) Brid.

Very common.

One of the most frequent mosses, both on a dry and on a somewhat damp substratum, from the lowlands to far up in the Alpine region. It grows in soil-filled rock-clefts, on dikes and house-walls, on peat and on the top of knolls in bogs. As a rule, it grows in small, unmixed tufts, but occasionally also mixed with other mosses. The fruit, which ripens during August, occurs plentifully everywhere.

187. **Plagiopus Œderi** (Gunn.) Limpr.

Bartramia Œderi (Gunn.) Sw.

E. Iceland: Berufjördur!, fr. N. Iceland: Hóf near Eyjafjördur (O. D.)!; Reistarárgil (O. D.)!, fr.

Near Berufjördur it grew abundantly on a wet rock-face with a northern exposure, in cushions, about 3 cm. high, with numerous capsules which were ripe at the end of June.

188. **Philonotis fontana** (L.) Brid.

Very common over the whole of Iceland.

One of the most frequent and abundantly occurring species which grows everywhere on a wet substratum, in marshes and moss bogs, along streams, and on wet rocks, but is also common on a more dry substratum, for instance in grass fields or on humus-covered rocks. It is of almost equal frequency at all elevations upwards to the limit of vegetation. The fruit, which is found very frequently, ripens in the low land about August 1st.

Philonotis fontana is extremely variable, and conditions pertaining to dampness especially exercise great influence over the appearance of the plant. The usual bog forms are highly tomentose, with erect or more or less falcato-secund leaves (f. *falcata* Warnst.). On a more dry substratum the tufts usually become denser and more highly tomentose, and the plants more slender.

In the cold water in moss bogs and on inundated ground along rivers where the temperature during summer is often only 4^0—6^0 this species, in association with *Pohlia albicans var. glacialis*, *Brachythecium rivulare* and species of *Mnium*, often forms the main part of the vegetation. Here it forms very high and loose, in fact hardly cohering, tufts, which often resemble *P. seriata* in habit. The stems are flaccid and hardly tomentose; the leaves are short and appressed or slightly secund, and often obtuse or cucullate at apex. The nerve is very broad and widened at the base. Such cold-water forms agree exactly with Loeske's *P. fontana-adpressa* (L. Loeske, Kritische Bemerkungen über einige Formen von Philonotis, Hedwigia, vol. 45, p. 100, and Kritische Übersicht der eur. Philonoten, Hedwigia, vol. 45, p. 195). That it is the cold water which checks the growth of the radicles and causes the

characteristic form of the leaves and the looser cell-tissue is seen from the fact that, in situations where the water-level is altered, forms may be found growing in tufts, in the lower part of which the stems are tomentose and the leaves normal, while all the young shoots which have developed after the habitat has been inundated have the typical *depressa* appearance. Likewise are found all possible transitions between *P. fontana* and the *depressa* form.

On mountain heights, where the snow lies long, the slopes are often covered with f. *nigrescens* Loeske, with black, prostrate and hardly to-



Fig. 8. *Philonotis fontana* (L.) Brid. Slender form from warm ground (Thorlákshver; nat. size).

mentose stems and light yellowish-green annual shoots. This form has beyond doubt originated from the pressure of the snow-covering. The leaves are, as a rule, shortly pointed. Where the water from the melted snow remains and soaks the tufts the leaves become still more shortly pointed and the cell-tissue looser (f. *borealis*, Hagen, Loeske). By hot springs *P. fontana* often occurs abundantly both in the lukewarm water and on the warm clayey flats. Here it forms very soft, not cohering tufts. The stems are erect and very slender; the leaves are small, often strongly falcato-secund, longly pointed, highly papillose, and sharply toothed along the margin, with narrow (0.05–0.06 mm. broad) nerve.

Note. *P. calcarea* from Frodarheidi (leg. H. J.) is *P. seriata*.

189. **Philonotis Arnellii** Husnot.

N. Iceland: Hof near Eyjafjördur (O. D.)!. SW. Iceland: Thingvellir!; between Reykjavik and Hafnarfjördur!.

Near Thingvellir it grew on a soil-covered rock-ledge in a cleft, in association with *Eucalyx subellipticus*, *Bartramia ityphylla* and *Pohlia cruda*. All the specimens found were ♂ plants.

190. **Philonotis seriata** (Mitt.) Lindb.

E. Iceland: Berufjördur!; Seydisfjördur!; Kirkjuból (H. J.)!. N. Iceland: Husavik!, at an elevation of 200—300 metres; several places near Eyjafjördur (O. D.;!); Mývatn (Grl.)!; common in Öxnadalur!. NW. Iceland: Very common by all the fjords from Dyrafjördur northwards!. W. Iceland: Frodarheidi (H. J. !; Esja, many places!. S. Iceland: Seljaland (Stp.)!.

Grows on inundated ground, as a rule in the water itself, for instance along streams and in moss bogs.

In NW. Iceland it is one of the most frequently occurring species, and is met with abundantly up to a height of above 400 metres above sea-level. It often forms in association with *Pohlia albicans*, *Scapania uliginosa*, *Haplozia cordifolia* and *Chiloscyphus polyanthus* v. *fragilis* the main portion of the moss-carpet along streams. In the other parts of the country — with the exception of S. Iceland where it has been found only near Seljaland -- it is rather common. It is usually met with from about 250 to 500 metres above sea-level, but frequently ascends up to about 600 metres, for instance by Berufjördur. The fruit, which was quite green even in the first half of July, has been found only in a few localities in the district of Isafjördur and near Eyjafjördur, and only scantily.

191. **Philonotis tomentella** Mol.

P. alpicola Jur.

Widely distributed over the whole of Iceland.

P. tomentella usually prefers drier localities than does the closely allied *P. fontana*. In N. Iceland, where it is very common, it grows abundantly everywhere on partially dry, grass-covered ground, and is easily distinguished from *P. fontana* by its more slender growth and by the extremely dense tufts, with stems covered with brown tomentum almost to their summit. It grows, also, both on rather dry and on damp rocks and on wet boggy ground in company with *P. fontana*, without, however, extending into the water itself.

It varies very considerably in habit and size. The leaves are more or less falcato-secund, and forms especially from dry rocks have leaves strongly falcato-secund (f. *falcata*). In shady localities, for instance in rock-clefts and caves, slender to almost thread-like forms (var. *capillaris*) are frequently met with. Forms growing in bogs are more vigorous than are those growing on a dry substratum, and are also less densely tomentose.

On damp rocks and in humus-filled rock-clefts there frequently occurs a slender form with numerous slender, easily falling branches which probably serve for vegetative propagation (f. *flagellifera*).

Limpricht (Kryptogamenflora, vol. II, p. 573) records that the

cortex in this species consists of 3—4 layers of sharply defined, small stereids covered with a sphagnoid outer cortex, while *P. fontana* has not a sharply differentiated cortical layer. This feature appears, however, to be closely connected with the degree of dampness of the habitat, so that forms from a dry substratum, both of *P. tomentella* and of *P. fontana*, have several layers of thick-walled cortical cells, while bog-forms have thin-walled cortical cells, and (as in *Dicranum scoparium* and *D. angustum*) all possible transitions may be found between thin-walled and thick-walled cortical cells.

Fruit occurs very frequently and ripens at the end of July or in the beginning of August.

Fam. TIMMIACEÆ.

192. **Timmia norvegica** Zett.

E. Iceland: Hof!; Vallanes (H. J.)!. N. Iceland: Pollar (St.)!; Akureyri!, at an altitude of 300 metres; Hof near Eyjafjördur (O. D.)!; Vidimýri (Grl.)!. S. Iceland: Vestmannaey!.

It grows on earth and in rock-clefts, but has been collected everywhere only scantily. Near Hof (E. Iceland) it grew on gravelly ground in association with *Oncophorus virens*, *Ditrichum flexicaule*, *Myurella julacea* and *M. apiculata* at an altitude of about 150 metres. Near Akureyri it was found sometimes in rock-clefts, in company with *Mnium orthorrhynchum*, sometimes on rocks mixed with *Philonotis tomentella*. Only sterile specimens have been found.

193. **Timmia austriaca** Hedw.

Very common especially in N. and E. Iceland, but more rare in NW. Iceland (Dýrafjördur, Isafjördur, Grunnavik!). It grows on earth or on soil-covered rocks, and often in masses. Thus in several places in Hallormstadaskogur it was the most abundant member of the moss-carpet under the birches, especially on knolls and soil-covered stones. In several places in N. Iceland, for instance in Öxnadalur, it covered the slopes along streams, often greatly mixed with other species.

Timmia austriaca is most frequent in the lowlands up to a height of about 300—400 metres, but is also often found on mountain heights (for instance on Seljaland at an altitude of about 620 metres) although usually in small quantity. Fruit has been found only near Tverá and Vidimýri in N. Iceland; it occurred plentifully in both places and had just ripened at the end of July.

Fam. POLYTRICHACEÆ.

194. **Catharinea undulata** (L.) Web.

E. Iceland: Hornafjördur!; Lon!; Berufjördur!. N. Iceland: Hof near Eyjafjördur (O. D.)!; Reykir near Svinavatn (Grl.)!. W. Iceland: Reykja-

vik (Mörch;!); near hot springs in Reykholtdalur (Grl.;!); Borgarfjördur!. Common in SW. and S. Iceland!.

Commonly distributed in SE., S. and W. Iceland from Lon in the south-east to Borgarfjördur in the west. In N. Iceland it has been found only near Eyjafjördur, and it has not been collected in NW. Iceland. It grows sometimes on peat, sometimes on damp clayey ground, for instance by sides of ditches, and is occasionally found in fruit, which about Reykjavik was quite undeveloped even in August. It is a decidedly low-land species, and has not been found at a higher elevation



Fig. 9. *Catharinea undulata* (L.) Web. var. *thermophila* (nat. size).

than 50—100 metres above sea-level. The usual forms of this species are low in growth, 1—2 cm. high, with leaves which are as a rule 4—6 mm. long, narrowly lanceolate, obtuse or shortly pointed, only slightly undulate with a few spines at the back, and the margin often with single teeth.

Catharinea undulata is one of the species which is found most frequently and abundantly on warm ground, where it occurs in rather divergent forms. Usually it resembles the southern woodland forms with long, strongly undulating leaves, very rough at the back. A very peculiar form is

Var. ***thermophila*** n. var.

Loose cushions as much as 10 cm. high. Leaves evenly distributed along the whole length of the stem, or somewhat denser at the top, often falcato-secund, 6—7 mm. long, linear-lanceolate, sharply pointed, with 4—5 lamellæ at the back. Lateral shoots are often developed along

the stems. This form grew abundantly near the hot springs about Skálholt, especially on the slopes stretching down towards the outlets of the springs.

195. **Oligotrichum hercynicum** (Ehrh.) Lam.

Oligotrichum incurvum (Huds.) Lindb.

Iceland (Mörch). E. Iceland: Seydisfjardarheidi!. N. Iceland: Ljosavatn!, common 350 metres above sea-level and upwards; Askja (Caroe!). NW. Iceland: Very common!. W. Iceland: Stadarfell (Stp.); Esja!, at an altitude of 400—500 metres; Reykholtdalur (Grl.;!); Hafnarfjördur!. S. Iceland: Common from about 350 metres and upwards!; Krisuvik (Stp. !); everywhere near hot springs!.

This species has a very peculiar distribution in Iceland. It has its main area of distribution on the mountain heights, where it doubtless occurs over the whole of Iceland, and often in masses. It grows here on damp gravelly flats, especially in the neighbourhood of the snow-patches, in association with *Anthelia Juratzkana*, *Pleurocladia albescens*, *Pohlia gracilis*, *Polytrichum sexangulare*, etc., and as a rule sets fruit. Scarcely anywhere has it been found until at a height of 350—400 metres, and was most abundant at about 500—700 metres above sea-level. Only in NW. Iceland, where it is exceedingly common, did it descend to a lower altitude, in many places as low as to the sea-level. In the greater part of the country it is quite absent from the low land; in SW. Iceland it has been found only scantily in a lava cave near Hafnarfjördur.

This species has another area of distribution near the hot springs in SW. and W. Iceland. Here it has been collected near a great number of springs in Reykholt- and Reykirdalur, around Skálholt and in several other places, where it often occurs abundantly on the warm clayey flats, but only sterile. These warm-soil forms differ somewhat from the Alpine forms. As a rule they are quite low in growth, about 5—10 mm. high, with softer leaves, twisted or incurved when dry, with a few (5—6) lamellæ at the back. The leaf-cells are more thin-walled, chlorophyllous, larger and more regularly quadrate and transversely elongated, usually 0.015—0.018 mm., but occasionally also 0.025 mm. in diameter, shortly rectangular at the base, 0.018 mm. broad. The nerve is often only half as broad as in the Alpine form. Such forms grow especially on the warm clayey flats, in company with *Anthoceros*, *Fossombronia*, *Haplozia crenulata* and other hepatics. Near Deildartunguhver in Reykholtdalur it grew on the warm ground among other mosses, in tufts about 3 cm. high. Forms exactly resembling the Alpine forms occur also frequently on the warm ground.

In the majority of the localities in NW. Iceland the fruit was ripe in the latter half of June, on the mountain heights early in July.

196. **Psilopilum lævigatum** (Wahlb.) Lindb.

Oligotrichum glabratum Lindb.

O. lævigatum Br. eur. *Psilopilum arcticum* Brid.

E. Iceland: Hornafjördur!; Berufjördur!; Seydisfjördur!. N. Iceland: Husavik!; Akureyri!; Hof near Eyjafjördur (O. D.)!; Geitaskard!. NW. Iceland: Isafjördur!; Snæfellsströnd!. W. Iceland: Stykkisholmur!; Stadarfell (Stp.)!; Hafnarfjördur!; Reykjavik (Mörch; Ho.; Stp.;!). S. Iceland: Common in Ölfus!.

Commonly distributed everywhere near the coasts. It grows there on rather dry peaty ground, and often in great abundance. For instance near Reykjavik it covers in association with *Dicranella crispa*, *Bryum pallens*, *Scapania curta*, etc. large tracts of ground on the peninsula. It appears to thrive more particularly in drained bogs whence peat is being cut; thus around Husavik, Akureyri and Isafjördur it occurred in very great abundance, partly on the ground and partly on the piled up heaps of cut peat, which were often quite covered by it. *Funaria hygrometrica* and *Pogonatum urnigerum* often occurred abundantly in company with it. Fruit ripens in the beginning of (Reykjavik) or at the end of June (N. Iceland).

Note. F. Hagen in his preliminary works on a Frondose-Moss Flora of Norway (XIX, *Polytrichaceæ*) supposes that *Psilopilum tschuctschicum* (Müll. Hal.) Par. has been collected in Iceland by W. F. Hooker. All the specimens I have had an opportunity of investigating, both numerous older specimens collected by Mörch, Krabbe, Grönlund and others and my own specimens collected in a considerable number of habitats from all parts of Iceland, belong to *Psilopilum lævigatum*, which is doubtless the only species of this genus found in Iceland.

197. **Pogonatum polytrichoides** (L.) Brockm.

Pogonatum nanum (Schreb.) P. B. *P. subrotundum* Lindb.

Iceland (Ho.; Mörch)!. W. Iceland: Reykjavik (Grl.;!); Stykkisholmur (Stp.)!; Sletta (Stp.); in the district of Borgarfjördur!. S. Iceland: Near the Thjorsá (Stp.)!; frequent in Ölfus!.

This species was found only in SW. and W. Iceland, but was rather common in both places on somewhat damp and especially peaty soil, for instance by the sides of ditches and along roads. In the district of Borgarfjördur it was common along roads. Around Reykjavik it was found everywhere by the sides of ditches. Fruit was found everywhere, the capsules were partly old specimens from the previous year and partly such as were quite young even in August.

Note. *Pogonatum aloides* (Hedw.) is recorded to have been collected by Steenstrup near Sletta, Stykkisholmur and the Thjorsá, but all the specimens belong to *P. polytrichoides*.

198. **Pogonatum dentatum** (Menz.) Brid.

Var. **minus** (Wahlb.) Hagen.

Reykjavik!.

Here it grew in several places on peaty soil, and in one place very abundantly, with numerous capsules, some of which were almost ripe in the first half of August.

199. **Pogonatum urnigerum** (L.) P. B.

Polytrichum urnigerum L.

Widely distributed over the whole of Iceland.

Grows usually scattered as individual plants, or a few plants together, among other mosses on dry, humus-covered rocks or on the ground, both dry and somewhat damp; for instance along the banks of streams. It occurs in large quantities on peat, often forming large light-green patches, interwoven with *Alicularia scalaris* and, occasionally, *Scapania curta*. On somewhat damp, moss-grown slopes it often forms large tufts several centimetres high among *Hylocomium* spp., *Hypnum uncinatum* and *Polytrichum alpinum*; such vigorous forms are also frequently met with in South Iceland on somewhat damp ground, for instance by the sides of ditches. It is most frequent in the lowlands and does not appear to ascend above 300—400 metres. The fruit, which only occurs on large plants growing in tufts, was ripe or overripe in the beginning of June.

200. **Polytrichum alpinum** L.

Very common everywhere both on dry and on somewhat damp ground, and almost equally frequent from the sea-level up to the limit of vegetation on mountain heights. It grows both mixed with species of *Hylocomium* and interspersed in *Rhacomitrium*-mats on knolls in bogs, on peat, in grass-fields and on the stony slopes of mountain heights. The fruit, which occurs very frequently, ripens in the lowlands about August 1st.

Varies considerably in habit, length of leaf, form of capsule, etc., but the majority of the forms, however, approach closest to the type. Forms agreeing more or less with var. *septemtrionale* Sw. Brid. are also common.

201. **Polytrichum formosum** Hedw.

W. Iceland: “Sæluhusid” in Sókkólfdalur (F.)!, sterile.

202. **Polytrichum gracile** Dicks.

Rather common over the whole of Iceland.

This species grows in peaty soil, often abundantly, and sets fruit almost always. It occurs only in the low land and has hardly been

found at a higher level than 200—300 metres. Near Akureyri the fruit was ripe at the end of July.

Var. ***anomalum*** (Milde) Hagen.

Hof near Eyjafjördur (O. D.)!. NW. Iceland: Hesteyri!.

In both these places it was collected scantily only. Near Hof it occurred as a few scattered individuals in a specimen of the vegetation taken from wet boggy ground. Near Hesteyri it grew on very wet boggy ground. The plants were about 3 cm. high and sterile. Some of them agreed with var. *anomalum;* in some the leaves at the base of the stem resembled in structure those of the variety in having thin-walled cells 0.020—0.025 mm. in size, while the leaves in the upper part of the stem resembled in structure those of the type in having cells 0.015—0.020 mm. in size.

Var. *anomalum* is undoubtedly a hygrophilous form of *P. gracile*, which develops when the habitat is inundated.

203. **Polytrichum sexangulare** Floercke.

Iceland (Mörch)!. N. Iceland: Ljosavatn!; Reykjaheidi!; common near Eyjafjördur (O. D.;!). NW. Iceland: Very common!. W. Iceland: Esja!; Kolvidarhol!. S. Iceland: Seljaland!; Holt!; Thingvallahraun!.

Var. ***vulcanica*** C. Jens.

"Seta perbrevis usque ad 4 mm. longa; apophysis valde indistincta; capsula non angulata, vetusta nigrescens et irregulariter 4—5-gona; Cetero typo simile."

S. Iceland: The volcano on the road to Holt (Stp.)!.

Var. ***tenellum*** n. var.

Plants 1—2 cm. high, more slender than the type, with shorter, narrower, more slightly incurved and not secund leaves, when dry; the nerve excurrent in a short mucro; otherwise exactly like the type.

S. Iceland: Barkarstadr!; Drángshlid!; Seljaland!.

Polytrichum sexangulare has a very peculiar distribution in Iceland. The type is a decidedly Alpine plant which does not feel quite at home until near the snow line, on the gravelly flats soaked by the melting snow. In N. Iceland it has been collected only at elevations of above 500 metres. In NW. Iceland, where the species is very common, it is met with everywhere from about 200—300 metres upwards. On northern slopes where the snow lies long it sometimes descends as far down as to the sea-level. Near Kolvidarhol it was common at about 400 metres, and on Esja everywhere at elevations of above 500 metres.

P. sexangulare has not yet been collected in E. Iceland, but the reason can hardly be that it does not occur there, it must rather be due to the fact that the mountain heights were almost everywhere snow-covered at the time of the year (June, 1909) when there was an opportunity of making collections there. This species has an area of distribution not only on the mountain heights, but also in the lowlands.



a a a a b b b

Fig. 10. *Polytrichum sexangulare* Floercke var. *tenellum*.
a, in a damp, and *b*, in a dry condition (× 6).

In lava clefts near Thingvellir and in deep lava clefts on Reykjarheidi (at an altitude of about 250 metres) it was found abundantly in several places in association with several other Alpine species, for instance *Gymnomitrium concinnatum*, *G. varians*, *Pleuroclada albescens* and *Pohlia commutata*. The occurrence of this species in such localities is undoubtedly connected with the fact that there the conditions pertaining



a b c d

Fig. 11. *Polytrichum sexangulare* Floercke var. *tenellum*.
a, *b* and *c*, leaves (× 15); *d*, leaf-apex (× 100).

to soil present certain points of resemblance to the mountain heights, as the snow in the deep clefts, the bottom of which is never reached by the rays of the sun, often remains till late into the summer. The occurrence of var. *tenellum* is more peculiar. It has been found only in S. Iceland, where it grew exclusively on dry or slightly damp blocks of tuff in the lowlands. But only near Seljaland did a few small tufts occur on a block of tuff at an altitude of about 600 metres. Near Drángshlid it grew abundantly on the fallen blocks of rock at the foot of the rock-wall behind the farm. There in company with *Hypnum cupressiforme*, *Ceratodon*, *Didymodon rubellus*, *Rhacomitrium fasciculare* and *Bryum argenteum* it formed tufts of varying size on the top of the blocks in dry situations. Near Barkarstadr it was found on a somewhat damp tuff-face, and creeping over fallen blocks of rock, in association with *Pohlia cruda*, *P. grandiflora*, *Anæctangium compactum*, *Bryoxiphium norvegicum* and *Anthelia* spp. The plants from these habitats were quite sterile, and exactly alike in all respects.

The fruit, which is common in the Alpine form, ripens in August (Akureyri: ripe Aug. 13th; near Isafjördur: green in the first half of July).

204. **Polytrichum piliferum** Schreb.

Polytrichum pilosum Neck.

Iceland (Mörch)!. E. Iceland: Vallanes (H. J.;!). N. Iceland: Reykjahlid (Grl.;!). NW. Iceland: Bildudalur (C. Hansen;!); Gnupr near Dyrafjördur!; Ármuli!; Arngerdareyri!. W. Iceland: Stykkisholmur (H. J.;!); Grund in Skorradalur!; common near Reykjavik!; Videy!; Hafnarfjördur (Wiinstedt)!. S. Iceland: Krisuvik (Stp.;)!; Drángshlid!.

Occurs here and there, and is rather rare in the majority of the districts of Iceland. It grows on dry sandy ground, upon soil-covered rocks and on dikes, often singly among other mosses. It is absent from or rare in the most rainy parts of the country, for instance at the East coast and in South Iceland and is most frequent in those districts where the rainfall is least. Thus it occurs abundantly near Myvatn, where it is common in the lava-field. It is also rather widely distributed in NW. Iceland, here it is often found in abundance, for instance on sandy fields near Ármuli and on rocks near Arngerdareyri. Fruit is common and ripens in the latter half of June.

205. **Polytrichum juniperinum** Willd.

Commonly distributed.

It grows on more or less dry ground, for instance on knolls in bogs, in the *Rhacomitrium-canescens* heath, on slopes among *Hylocomium* and *Rhacomitrium* etc., usually scattered among other mosses, more rarely in cohering tufts, and almost always sets fruit which ripens at the end of June and in the beginning of July (Seydisfjördur, July 6th; Isafjördur, June 24th).

It is most widely distributed in the lowlands and does not appear to ascend much higher than about 400 metres above sea-level.

206. **Polytrichum strictum** Banks.

E. Iceland: Hornafjördur, common!. N. Iceland: Husavik!; Akureyri, common to about 600 metres above sea-level!; Hof near Eyjafjördur (O.D.)!; common from Geitaskard westwards to Hrutafjördur!. NW. Iceland: Common around Isafjördur!; Grunnavik!; Kaldalon!. W. Iceland: Grund in Skorradalur!; Ólafsdalur (H. J.)!; Reykholtdalur, common!; Reykjavik!. S. Iceland: Skálholt!, ♂; Geysir (Stp.)!.

Occurs rather commonly and often abundantly on wet boggy ground, but always sterile. In Reykholtdalur it also grows on warm ground.

207. **Polytrichum commune** L.

Widely distributed on damp ground, both in bogs and along the banks of streams, but as a rule rather scantily.

In the low land, where *P. commune* has its greatest distribution, the large coarse form is usually met with. In higher regions, where it is found up to a height of about 500 metres, it usually becomes slenderer and lower in growth. Thus, near Akureyri, it occurred abundantly in a bog at an altitude of 500 metres as a low-growing, slender form. mixed with *Hypnum stramineum*.

P. commune is one of the most frequent species near hot springs, where it grows sometimes mixed with *Sphagnum* and is then large and vigorous, sometimes in extensive mats interwoven with hepatics and is then usually low in growth with shorter leaves. On a warm substratum it often fruits freely, while it has or else been found in fruit only near Grunnavik in NW. Iceland.

Var. ***fastigiatum*** (Lyl.) Wils.

SW. Iceland: Svinahraun!, abundantly on damp soil at the edge of the lava-field.

208. **Polytrichum Swartzii** Hartman.

NW. Iceland: Bæir!, sterile.

Var. ***nigrescens*** (Warnst.) Hagen. Syn. *Polytrichum inconstans* Hagen.

NW. Iceland: Thoroddstadaengjar (St.)!; Dýnjandi!.

The type grew on a damp slope in not-coherent tufts, about 15 cm. high; the plants were quite typical with sharply toothed leaves, and with lamellæ, the marginal cells of which had the irregular form peculiar to *P. Swartzii*. The variety grew on very wet or inundated ground in company with *Hypnum stramineum*, *H. giganteum* and *Mnium cinclidioides* similarly to *P. gracile* var. *anomalum*, and may be regarded as a form similar to the latter; as in aquatic forms of other species, both forms have flaccid-soft leaves with slightly developed stereom in the nerve and broader, slightly toothed leaf-margin; in the plant from Dýnjandi the leaf-margin was almost entire.

Fam. BUXBAUMIACEÆ.

209. **Diphyscium sessile** (Schmid.) Lindb.

Webera sessilis Lindb.

Common in East, South and West Iceland, and rather frequent in North-west Iceland, where it is common for instance in the district of Dyrafjördur. In North Iceland it has not been found east of Blóndudalur.

It grows on firm, bare ground, especially on the top of knolls or on small elevations of earth on slopes, where it forms low, dense cushions, dark brown in colour; it is common, at any rate in E. Iceland, as far upwards as 600—700 metres above sea-level. Fruit, which occurred only scantily in all places, was collected near Reykjavik, near Lundur in West Iceland and near Geitaskard in Blóndudalur.

Fam. FONTINALACEÆ.

210. **Fontinalis antipyretica** L.

Found in all parts of the country and common on stones in brooks and rivers, and sometimes also in stagnant water, up to about 300—400 metres above sea-level. Near Ljosavatn in N. Iceland it was found abundantly in a river even at an altitude of 300—400 metres, and near Isafjördur it occurred frequently as far upwards as 300 metres. It varies considerably in size, leaf-form and colour. In stagnant water (thus in very wet bogs near Jökulsfjördur) it becomes very robust, light brownish-yellow, with broad leaves.

In swiftly flowing water there often occur slender, dark-green or brownish-green forms with strong metallic sheen, which agree most closely with var. *montana* H. Müller. In such forms the basal angles of the leaves are often somewhat concave, and formed of a single layer of cells, in which respects it comes very near to *F. gracilis.* This species is recorded from several localities by Grönlund, H. Jónsson and Feddersen, but all the specimens which have been investigated belong either to *F. antipyretica* or to *F. androgyna.* Only sterile specimens have been found.

211. **Fontinalis islandica** Cardot.

E. Iceland: Faskrudsfjördur (Jardin, 1865) specimens not inspected).

212. **Fontinalis longifolia** C. Jensen (Bot. Not. 1885, p. 83).

"Gracilis, viridis et flavoviridis, elongata, mollis, rubricaulis, ramulis brevibus, patulis subremotis. Folia laxa, imbricata vel erecto-patentia mollia, carinata, annosiora, bifida, ovato-lanceolata, sensim longe acuminata, integra vel ad apicem lenissime serrulata, decurrentia, cellulis

flexuoso-linearibus, apicalibus brevioribus, angulorum multo majoribus, rectangulis. Folia ramulorum angustiora. Flores et fructus ignoti."

This species, which was first found by Feddersen in the Helgá in S. Iceland, grew very abundantly on stones in the Reykirdalsá in SW. Iceland. This river has copious influx from the hot springs, so that, in the first days of June, the temperature of the water was about 12°, which was essentially higher than in the majority of the other rivers where the temperature was, as a rule, only about 4°—6°.

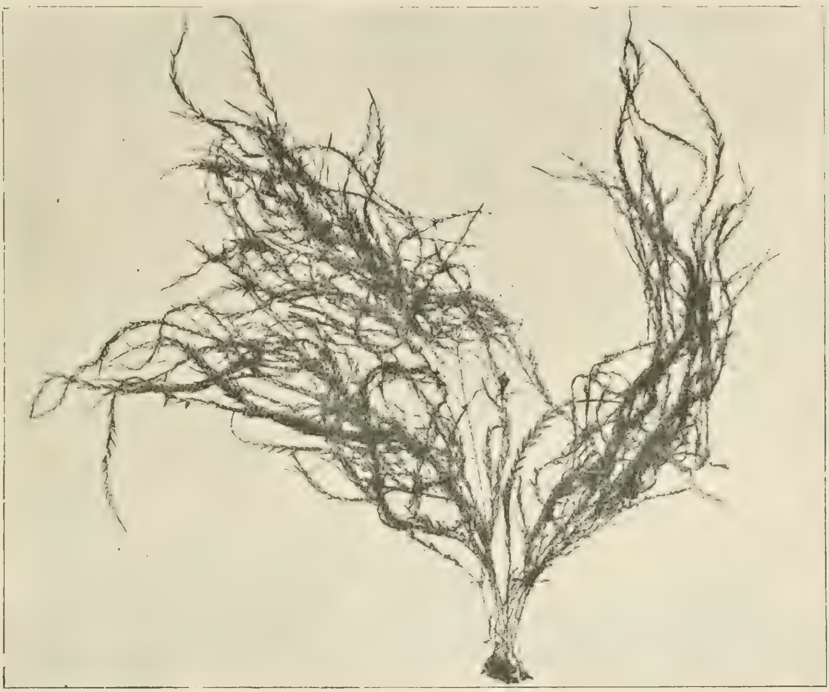


Fig. 12. *Fontinalis longifolia* C. Jens. (Reykir; somewhat reduced).

Fontinalis longifolia agrees most closely with *F. hypnoides* R. Hartm. The plant from the Reykirdalsá is rather robust, as much as 25 cm. long, very strongly and irregularly branched, with rhizoid-cushions around all the points whence the branches issue, and with plane or somewhat concave, longly tapering, very soft leaves, which only exceptionally are folded along the median line. The ♂ plant is more slender than is the ♀ plant, with very numerous, narrowly ovate ♂ flowers, which often occur in clusters of 2—4 on the main axis and branches and contain each 2—4 antheridia. The fruit, which in the beginning of June was developed to almost full size, but was as yet quite green, so that the peristome and spores could not be investigated, was found scantily on the lowermost part of the stem. As in *F. hypnoides* the capsule was half-exserted.

213. **Fontinalis thulensis** C. Jensen (Bot. Tids. 20, p. 110).

"Laxe caespitosa, sat robusta, mollis, sordide luteola, inferne nigrescens subnitida. Caulis usque ad 25 ctm. longus, inferne plerumque nudus, plus minusque ramosus, ramis brevibus vel elongatis, erecto-patentibus, vel subsecundo-arcuatis, interdum acutis, cauli primario sat similibus. Folia dimorpha, tristicha; folia caulina erecto-patentia vel laxe imbricata, plus minusque distincta et recte carinata, interdum tantum complicata, late ovata-lanceolata, longe decurrentia integra vel apice indistincte denticulata, adultiora subobtusa, juniora acuta, nunquam bifida, superiora vulgo 5—6 mm. longa et 2—3 mm. lata, inferiora minora, latere uno versus basim reflexo; folia ramulina minora et subangustiora, vulgo 3—4 mm. longa et 1,5—2 mm. lata, inferiora multo minora omnia ecarinata, valde concava, interdum complicata, erecto patentia, inferiora ramorum arcuatorum arcte imbricata, superiora interdum subsecunda. Cellulae in media foliorum 0,007—0,013 mm. latae, 8—12 plo longiores. Alae basilares, planae, unistratae, e cellulis quadratis et hexagonis, aeque ac ceteris cellulis basilaribus, luteis formatae. Cetera ignota.

Speciei americana *F. Kindbergii* valde affinis, sed ramis erecto-patentibus, non pennatis, foliis eorum brevioribus et latioribus, cellulis angustioribus, colore luteolo *F. Kindbergii* ferrugineus est et nitore debiliore."

W. Iceland: The Laxá (Hjarðarholt), 21.7.1886 (Feddersen).

Note. *Fontinalis squamosa* L. is enumerated on older lists, but of the specimens from Iceland, contained in the collections, some belong to *F. antipyretica*, some to *F. androgyna*.

214. **Fontinalis androgyna** R. Ruthe.

W. Iceland: The Ellidará near Reykjavik (Mörch; Grl.; H. J.;!).

In the Ellidará it grew abundantly in company with *F. antipyretica* on large stones and rocks under water. There not only ♂ ♀ buds were found, but also a few ripe capsules on the lowermost part of the stem (5. 8. 1909).

Fam. CRYPHÆACEÆ.

215. **Leucodon sciuroides** (L.) Schwgr.

S. Iceland: Foss (H. J.)!; Drángshlid (H. J.;!); Stjörnarsandur (H. J.)!; Hrutafell!. SE. Iceland: Hornafjördur!; Hof!. SW. Iceland: Hafnarfjördur!.

All the Iceland specimens belong to var. *morensis* (Schwägr.) de Not. It grows on dry rock-walls with a southern exposure, both on tuff and on basalt, and appears to be rather frequent from Hof in SE. Iceland throughout S. Iceland to Hafnarfjördur in SW. Iceland. It occurred abundantly on Hrutafell and Drángshlid, and covered the vertical faces of tuff-rocks for long distances. Here it was also richly fruiting with capsules which were partly ripe at the end of June.

216. **Antitrichia curtipendula** (Hedw.) Brid.

E. Iceland: Hornafjördur, common!; Djupivogur!; Hof!; Starmyri!; Berufjördur!. N. Iceland: Mödruvellir Thóroddsen !; Geitaskard!; common in Vatnsdalur!. NW. Iceland: Patreksfjördur!; Kaldalon!. Common in W. and SW. Iceland!.

Common in SE. Iceland as far as Berufjördur (where it was found in one locality only), in S. and W. Iceland and the western part of N. Iceland from Blóndudalur. Rare and scanty in NW., N. and E. Iceland. It grows usually on a rather dry substratum, on stony slopes, and soil-covered rocks, but especially on moss-grown slopes in company with *Hylocomium* spp., and on the ground in coppices. In Esja it is common up to a height of 300—400 metres above sea-level. Only sterile specimens have been found.

Fam. NECKERACEÆ.

217. **Neckera complanata** (L.) Hüb.

W. Iceland: Gilsbakki!; Bardshellir (Grl.)!. S. Iceland: Paradishellir (Stp.)!; Reykir!; Austarhlid near Geysir!; Breidabolstadr!; Barkarstadr!; Holt!; Drángshlid!; Hrutafell!.

Rare in W. Iceland, and rather common in S. Iceland. It grows everywhere on the roof and sides of dry caves, which it often covers with its extensive, dark-green mats. Only sterile specimens have been found.

Fam. LESKEACEÆ.

218. **Myurella julacea** (Will.) Br. eur.

Very common on rocks, especially in humus-filled clefts; occasionally also on the ground, for instance on knolls in bogs. It often occurs in unmixed cushions, but far more frequently mixed with other mosses, and is met with both on a dry and on a somewhat damp substratum. On wet rocks it often grows in association wit *Anœctangium Mougeottii*, *Philonotis*, *Blindia acuta*, etc.; in dry clefts in company with *Mnium orthorrhynchum*, *Plagiothecium Roesei*, *Bartramia ityphylla*, *Pohlia cruda*, etc.; or it may be met with on dry rocks woven into the tufts of *Hypnum revolutum* and *Grimmia* spp. It does not appear to ascend higher than 300—400 metres. Only sterile specimens have been found.

219. **Myurella tenerrima** (Brid.) Lindb.

Myurella apiculata (Hüben.) Br. eur.

Grows quite similarly to the preceding species and, as a rule, in company with it, and in the majority of the districts of Iceland is almost as common. In S. Iceland it appears, however, to be somewhat

rarer. It is most frequent in rather damp situations, for instance on rocks near waterfalls. Only sterile specimens have been found.

220. **Leskea nervosa** (Schwägr.) Myrin.

SE. Iceland: Hof!, on rocks in company with *Metzgeria furcata*, sterile. S. Iceland: Drángshlid!; Hrutafell!, sterile. In both the latter localities it occurred abundantly on dry tuff-faces or on large fallen blocks.

221. **Leskea catenulata** (Brid.) Mitten.

Nupsdal (Stp.)!.
Here, Gnupsdalur near Dýrafjördur in NW. Iceland is probably meant.

222. **Anomodon viticulosus** (L.) Hook. et Tayl.

S. Iceland: Hrutafell!; cave near Skógafoss!. Vestmannaey!.
On Vestmannaey it grew at the foot of a dry, stony slope below Stora Klit; near Hrutafell it grew sometimes on rocks, sometimes on soil-covered rock-ledges. Only sterile specimens have been found.

223. **Pterigynandrum filiforme** (Timm) Hedw.

Very common everywhere.
The most frequent form is var. *decipiens* (W. et M.) Limpr., which occurs abundantly everywhere on dry rocks, especially on perpendicular basalt-faces, where it often forms very large cushions 5—6 cm. deep. Here all transitional forms are also met with between the type and the variety. The type is developed in deeper shade and occurs especially in clefts and crevices, where it forms thin, adherent mats on the surfaces of stones. Only sterile specimens have been found.
Both forms are common up to about 300—400 metres above sea-level.

224. **Lescuræa decipiens** (Limpr.)

Ptychodium decipiens Limpr.

E. Iceland: Berufjördur!♀, at an altitude of 80 metres.
var. ***crassirete*** n. var.
Leaf-cells very thick-walled, highly porous and distinctly papillose in the upper half of the leaf. Nerve very strong, 0.040—0.045 mm. broad for almost its entire length.
NW. Iceland: Gnupsdalur, at an altitude of 280 metres!.
L. decipiens is closely allied to *L. saxicola* and is often difficult to distinguish from the latter species. Peculiar to both are the narrow, highly thickened and porous leaf-cells, which in *L. decipiens* are more or less distinctly papillose with a papilla at each of the uppermost cell-angles, at the back towards the leaf-apex; while *L. saxicola* almost always has quite smooth leaves. In *L. saxicola* the upper half of the

leaf-margin is almost straight in outline, while in *L. decipiens* it is distinctly concave, as in *L. filamentosa*.

The variety grew abundantly on somewhat damp rocks; it is somewhat coarser and less branched than the type which it resembles exactly in leaf-form and size of the cells. The leaf-cells in this form are so highly thickened and porous that the walls almost appear like a string of beads and are often broader than the cell-space.

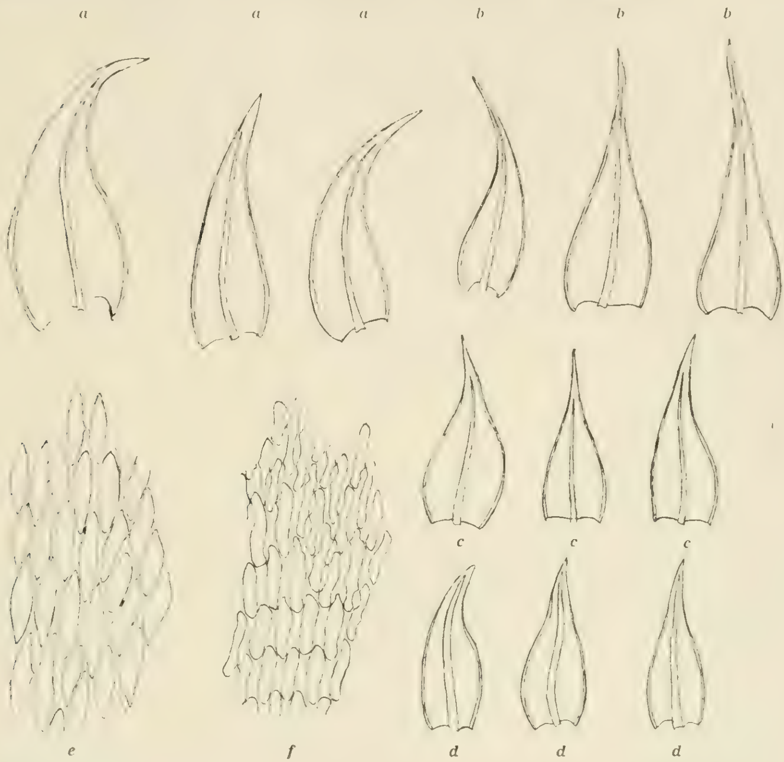


Fig. 13. *a*, Leaves of *Lescuræa Breidleri* (× 20); *b*, leaves of *L. radicosa* (× 20); *c*, leaves of *L. decipiens* (× 20); *d*, leaves of *L. decipiens* v. *crassirete* (× 20); *e*, leaf-cells of *L. decipiens* (× 320); *f*. leaf-cells of *L. decipiens* v. *crassirete* (× 320).

225. **Lescuræa radicosa** (Mitt.) Hagen.

Lescuræa rigescens (Wils.) Br. eur.; *Pseudoleskea radicosa* (Mitt.) Lindb. *Ptychodium Pfundtneri* Limpr.

N. Iceland: Öxnadalur, Tverá!; sterile.

In the above locality it grew scantily on a stone by the river.

226. **Lescuræa filamentosa** (Dicks.) Lindb.

Pseudoleskea atrovirens (Dicks.) Br. eur.

Widely distributed.

Grows on stones and dry or somewhat damp rocks, and appears to be frequent, although not abundant, in all parts of the country up to about 300 metres above sea-level. In NW. Iceland it is very common on stony slopes, and is often richly fruiting while it has or less been found sterile only.

227. **Lescuræa Breidleri** (Kindb.) Arn. et Jensen.

Ptychodium oligocladum Limpr.

E. Iceland: Berufjardarskard!, at an altitude of 600 metres; Seydisfjördur!, 500 metres. N. Iceland: Reykjahlid!; Akureyri, at an altitude of about 770 metres!. Grimsey (O. D.)!; Öxnadalsheidi (Grl. !. NW. Iceland: Dyrafjördur!; Gnupsdalur!; Isafjördur!; Sugandafjördur!; Grunnavik!. S. Iceland: Barkarstadr!, at an altitude of 530 metres.

Frequent on rocks and stones in the more highly situated parts of the country. It occurs in greatest abundance and in its most typical form on mountain heights at elevations of above 500—600 metres, where it is often the most abundant constituent of the vegetation. It has its main distribution in NW. Iceland, where, for instance around Isafjördur and Sugandafjördur, it occurs very abundantly on the rocky flats from about 200 metres upwards. ♀ plants are common, ♂ plants and fruit have not been observed.

Lescuræa filamentosa and *L. Breidleri*, judging from the Iceland specimens, are well-defined forms which, as a rule, may easily be distinguished from each other.

L. filamentosa is the lowland form, which has its main distribution in the birch region, and does not ascend much higher than about 300 metres above sea-level. Here it forms low, dense, dark-green or blackish-green tufts on stones, and prefers somewhat damp localities. ♂ plants are very frequent, ♀ plants occur more rarely.

L. Breidleri is the Alpine form, which descends only by exception to the upper limit of the birch region. It forms deep, loose, yellowish tufts of great extension upon the dry stony slopes of the mountain heights, or upon large blocks of rock. Only sterile ♀ plants have been found. Both the habit and the colour easily distinguish the two species from each other. *L. Breidleri* is almost branchless, but with some long, ascending branches often hook-shaped at the apex; *L. filamentosa* is densely and irregularly branched. In its most lowly situated habitats, for instance near Reykjahlid at an altitude of about 300 metres, and in some localities in NW. Iceland, *L. Breidleri* shows, however, a tendency to develop forms which approach in habit the vigorous forms of *L. filamentosa* var. *brachyclados*. The leaf-cells in all the investigated specimens of *L. filamentosa* were short, oval or roundish and thick-walled, more or less but always distinctly papillose, frequently as far down as to the leaf-base, the nerve was very rough at the back, which features most certainly distinguish doubtful forms from *L. Breidleri*. In the latter species the leaf-apex is longer, the nerve is narrower towards the apex and usually smooth, rarely indistinctly toothed at the back. The leaf-tissue in *L. Breidleri* is much more translucent than in *L. filamentosa*,

and is formed by prosenchymatous cells 0.008—0.009 mm. broad and 3—4 times, at the apex about 6 times, as long, which are, as a rule, quite smooth, more rarely slightly papillose towards the leaf-apex. The leaf-margin in *L. Breidleri* is revolute for almost its entire length, so that only the apex itself is plane. In *L. filamentosa* the leaf-margin is sometimes plane, sometimes more or less revolute, and on the same plant leaves may be found with margins either quite plane or revolute to the apex, which effaces the difference between the type and the variety *brachyclados* (Schwägr.) Br. eur. This form, which occurs rather frequently in somewhat damp habitats, forms in several respects a transition to *L. Breidleri*, and has, as the latter, a well-developed central strand, while the usual forms of *L. filamentosa* never have a central strand.

228. **Lescuræa patens** Lindb.

Pseudoleskea patens (Lindb.) Limpr.

E. Iceland: Berufjördur!, ♀, 500—600 metres above sea-level. N. Iceland: Grimsey (O. D. ! fr.). NW. Iceland: Gnupsdalur near Dyrafjördur! fr.; Dynjandi! ♂. W. Iceland: Reykjavik!; Kollafjördur! ♂; Mödruvellir!, in several places up to a height of about 200 metres, ♂. S. Iceland: Barkarstadr, about 460 metres above sea-level.

Lescuræa patens appears to be rather widely distributed in all parts of Iceland. It is met with from the low land to high up in the Alpine region on somewhat damp, shady rocks or damp stony slopes, often very abundantly. Thus, in Gnupsdalur it occurred in masses on stony slopes from about 250—400 metres, in association with *L. filamentosa*, *L. Breidleri*, *Pohlia commutata*, *Brachythecium reflexum* and *Lophozia* spp.; and with numerous fruit which had just ripened on June 19th. Near Reykjavik it grew on the ground among large stones in a damp meadow, in company with *Schistidium gracile*.

Note. *Ptychodium plicatum* (Schleich.) Schimp. is recorded by Grönlund from Grimstunga and Reykjavik. The plant from Grimstunga is only a form of *Brachythecium albicans*, and that from Reykjavik of *Camptothecium lutescens*.

229. **Heterocladium squarrosulum** (Voit) Lindb.

Heterocladium dimorphum (Brid.) Br. eur.

E. Iceland: Berufjördur!; Hof!. N. Iceland: Mývatn (Grl.)!; Ljosavatn!; Hof near Eyjafjördur (O. D.)!. SW. Iceland: Thingvallahraun!; Kollafjördur!. S. Iceland: Kihlhraun!.

Occurred here and there on dry ground, especially on moss-covered slopes or in birch coppices. Near Hof in E. Iceland it grew on a stony slope (about 100 metres above sea-level) covered with *Hylocomium* spp. and *Rhacomitrium*. In Thingvallahraun it was found associated with *Hypnum uncinatum*, *Pohlia nutans* and *P. acuminata* on a small slope in the birch coppice. Only sterile specimens have been found.

230. **Thuidium tamariscinum** (Hedw.) Br. eur.

Vestmannaey: Heljusdalur and Stora Klit!. S. Iceland: Barkarstadr!; Holt!; Seljaland!.

Gliemann records that this species was found by Mörch, but there are no specimens of it in the collections.

This species was found only in the southernmost part of Iceland, where it is frequent in several places on Vestmannaey and along the whole stretch of country south of Eyjafjall. Here it grows especially in the clefts at the foot of rock-walls or among large stones. Near Seljaland it was found abundantly on slopes stretching down towards the Seljalandsá, associated with *Thuidium delicatulum*, *Camptothecium lutescens*, *Scleropodium purum* and *Hylocomium* spp.

231. **Thuidium delicatulum** (Dill., L.) Mitten.

NW. Iceland: Dýrafjördur (Hartz)!. W. Iceland: Esja!. S. Iceland: Reykirdalur!; Skálholt!; Breidabolstadr!; Barkarstadr!; Seljaland!; Holt!; Drángshlid!. SE. Iceland: Hornafjördur!.

Common from Hornafjördur in SE. Iceland throughout the whole of S. and SW. Iceland to Hvalfjördur. There it grew on grass-covered slopes, especially on somewhat damp ground, up to a height of about 200—300 metres; occasionally also on more damp meadow land. Near Barkarstadr it was common even at an altitude of about 320 metres.

T. delicatulum becomes especially luxuriant on warm ground. By the hot springs near Skálholt it grew abundantly in cushions almost 10 cm. deep, associated with *Hypnum stramineum*. *H. Lindbergii* and *Hylocomium squarrosum*. Only sterile specimens were found.

232. **Thuidium Philiberti** Limpr.

SE. Iceland: Hornafjördur!. SW. Iceland: Álafoss!. S. Iceland: Reykirdalur!; Holt!; Vestmannaey!.

This species has a quite similar distribution to, and often grows in company with, *T. delicatulum* from which it cannot be distinguished in the field. Near Álafoss it grew on boggy ground along the river. In Reykirdalur it was common on rather dry, moss-grown slopes; it was also common around Holt, south of Eyjafjall.

Thuidium Philiberti is a weak species which in a sterile condition can be distinguished from *T. delicatulum* only by the length of the leaf-apex; the length varies considerably, however, in the Iceland plants, leaves being sometimes found in which the apex is elongated hair-shaped with 4—5 cells, and sometimes such leaves in which the apex consists only of a single cell or of two. Only sterile specimens have been found.

233. **Thuidium abietinum** (Dill., L.) Br. eur.

E. Iceland: Hof!; Vallanes (H. J.;!). N. Iceland: Akureyri (Grl.;!); Hof near Eyjafjördur (O. D.)!; Mývatn!; Vidimyri (Grl.)!; Tverá in Öxnadalur!. W. Iceland: Esja!. S. Iceland: Barkarstadr!; Vestmannaey!.

Occurs here and there on dry stony or moss-grown slopes up to about 200 metres above sea-level, especially in N. Iceland, where it is rather common in many districts (around Eyjafjördur, in Öxnadalur, etc.).

234. **Thuidium lanatum** (Strömgr.) Hagen.

Thuidium Blandowii (W. et M.) Br. eur.

Very common from Höskuldstadr in E. Iceland throughout N. and W. Iceland to Borgarfjördur. In NW. Iceland it occurs here and there, for instance near Isafjördur, Kaldalon and Dýnjandi near Jökulsfjördur, but everywhere scantily only. In E. Iceland it has not been observed south of Berufjördur, and in W. Iceland it appears to be absent from the south of Borgarfjördur. In S. Iceland it has been found rather plentifully near Holt and Barkarstadr.

T. lanatum grows almost always in bogs, where, especially in N. Iceland, it is often the most abundant constituent of the vegetation. It is more rarely met with on wet, soil-covered rocks. It is most frequent in the lowlands up to about 300 metres; but near Akureyri it is frequent even at a height of 400—500 metres above sea-level, and near Barkarstadr up to about 400 metres. Fruit, which occurs everywhere, ripens in the first half of July.

Fam. HYPNACEÆ.

235. **Orthothecium rufescens** (Dicks.) Br. eur.

Stereodon rufescens (Dicks.) Mitt.

W. Iceland: Melar (Grl.)!, sterile.

236. **Orthothecium intricatum** (Hartm.) Br. eur.

Stereodon subrufus (Wils.) Lindb.

N. Iceland: Skagafjördur (Grl.)!; Thrastarholsárgil near Eyjafjördur (O. D.)!. S. Iceland: Breidabolstadr!; Skógafoss!; Vestmannaey!. SE. Iceland: Hornafjördur!.

On Vestmannaey it grew rather plentifully, sometimes on blocks of rock in Heljusdal, sometimes on damp slopes intermixed with other mosses. In the other stations it usually occurred on damp rocks, especially on tuff; thus on the sides of a cave near Skógafoss, and near Hornafjördur on the damp rock-faces near a waterfall.

237. **Orthothecium chryseum** Schwägr. (Br. eur.)

Stereodon chryseus Mitten.

Very common in E. and N. Iceland, rather scanty in NW. Iceland (Dýrafjordur and Sugandafjördur). In W. Iceland it was only found

rather scantily in Botnsdalur and in a few localities in Esja, and in S. Iceland it has not yet been observed.

It grows on a damp substratum, both on rocks and on soil up to about 400 metres above sea-level. Thus in N. and E. Iceland it is one of the most frequent species on wet gravelly ground. Only sterile specimens have been found.

238. **Cylindrothecium concinnum** (de Not.) Schimp.

Entodon orthocarpus Lindb.

N. Iceland: Vididalr (Grl.)!. S. Iceland: Ytri Skógar (H. J.)!.

239. **Climacium dendroides** (L., Dill.) W. et M.

Very common over the whole of Iceland.

Grows on damp substrata of every kind, especially in bogs, scattered among other mosses, but also on soil covered rocks and damp gravelly ground; frequent also on more dry ground among grass. It hardly ascends higher than about 300 metres. Fruit was found only in E. Iceland below Fjardarheidi.

240. **Isothecium myurum** (Pollich) Brid.

SW. Iceland: Hafnarfjördur!. S. Iceland: Holt!; Hrutafell!; Drángshlid!; Vestmannaey!.

This species was only found in the south-western part of the country, where it was, however, rather frequent; and in the district south of Eyjafjall it was abundant in several localities, especially near Drángshlid, where it grew abundantly at the foot of perpendicular tuff-rocks facing south. Only sterile specimens have been found.

241. **Isothecium tenuinerve** Kindb.

Isothecium myurum var. *piliferum* C. Jens.

E Iceland: Papey (St.)!. NW. Iceland: Dynjandi!; Arngerdareyri!. W. Iceland: Stykkisholmur!; Budahraun (H. J.)!; the hot springs near Reykjavik (Grl.;!); Videy!; Esja!; Hafnarfjördur!; the lava-fields around Reykjavik!. S. Iceland: Holt!; Thingvellir!; Kihlhraun!; Krisuvik Stp.)!.

Common in the southern and south-western parts of the country in lava caves and clefts, probably also common in W. Iceland. In NW. Iceland rarer; and only found in one locality in SE. Iceland Occurs in greatest abundance in lava clefts, for instance abundantly near Thingvellir. Only sterile specimens have been found.

242. **Homalothecium sericeum** (L.) Br. eur.

Very common over the whole of Iceland.

Grows on dry, more rarely on damp rocks, and often abundantly

in very extensive mats. It ascends to a height of about 400 metres above sea-level, and, for instance in Esja, is found abundantly even at an elevation of between 300—400 metres, on dry, steep rock-ledges. Fruit was found only near Breidabolstadr in S. Iceland, and in July it was empty of its spores.

243. **Camptothecium lutescens** (Huds.) Br. eur.

Hypnum lutescens Huds.

Iceland Wiinstedt !. N. Iceland: Hnukr in Vatnsdalur (St. !; common near Geitaskard in Blóndudalur!. NW. Iceland: Dýrafjördur!. W. Iceland: Breidabolstadr!; Lundur!; Esja!; Reykjavik Grl.:!. S. Iceland: Common!; Vestmannaey!. E. Iceland: Djupivogur!; Hornafjördur!.

Common in the southern and western parts of the country from Hornafjördur in East Iceland to Blóndudalur in North Iceland. It has not been found in the remaining part of North Iceland or in the greater part of East Iceland from Berufjördur northwards, and it is rare in North-west Iceland. It usually grows on dry, stony or grass-covered slopes or in coppices, occasionally also on rocks, but hardly extends higher than 200—300 metres.

The leaves in this species have occasionally in their upper part cells which are shorter, and the angles of which are more or less distinctly shaped like a papilla. This is most distinctly seen in the forms from Reykjavik and Djupivogur, both of which grew on rocks.

244. **Camptothecium nitens** (Schreb.) Schimp.

Hypnum trichoides Neck., Lindb.

Very common.

One of the most frequent mosses on wet rocks. It occurs also frequently on soil-covered rocks or on more dry ground mixed with other mosses. In bogs it often forms the bulk of the vegetation and very frequently sets fruit, which ripens in the beginning of July. It occurs most frequently and abundantly in the low land, but ascends, however, to 400—500 metres above sea-level.

The tomentose form is by far the most frequent. The smooth form, var. *atrichum* Kindb., appears to grow especially on rocks. It was found abundantly on soil-covered rocks close to the coast below Geithellir in E. Iceland.

245. **Brachythecium Mildeanum** (Schimp.) Schimp.

E. Iceland: Seydisfjördur (H. J.)!; Hamarfjördur!. SW. Iceland: Alafoss!.

On wet boggy ground: near Hamarfjördur it grew abundantly on inundated ground along the river.

246. **Brachythecium salebrosum** (Hoffm.) Br. eur.

Hypnum plumosum Huds.

Commonly distributed in all parts of the country.

This species grows, as a rule, on rather dry ground, for instance on grass-covered slopes and on stones; occasionally also on damp ground, but everywhere scantily only and usually mixed with other mosses. It is most frequent in the low land; near Akureyri it has, however, been found at an elevation of about 500 metres, and near Seydisfjördur about 400 metres above sea-level. Fruit has been found only near Reykir in S. Iceland.

247. **Brachythecium collinum** (Schleich.) Br. eur.

W. Iceland: Esja, Mödruvellir!, on damp rocks at an altitude of about 100 metres.

The form collected here differs in its somewhat more longly pointed stem-leaves and narrower, more slightly toothed, branch-leaves.

Note. *Brachythecium plumosum* (Sw.) Br. eur. is recorded by Grönlund from several localities, but all the specimens of it in the collections have been wrongly determined and the majority of them belong to *Hypnum palustre*.



Fig. 14. *Brachythecium longipilum*. Habit (× 3).

248. **Brachythecium longipilum** n. sp.

Monoicum. Flores masculini in cauli primario numerosa, antheridiis c. 10 sordide flavis et paraphysibus paucis. Cæspites humiles, densi

saturate virides, habitu fere formæ gracilis *Brachythecii velutini.* Caulis repens, dense tomentosus, 2—3 cm. longus, 0.25 mm. crassus, ramos erectos numerosos, 4—5 mm. longos emittens. Folia caulina non decurrentia e basi late ovata vel triangulo-cordata in cuspidem longissimum

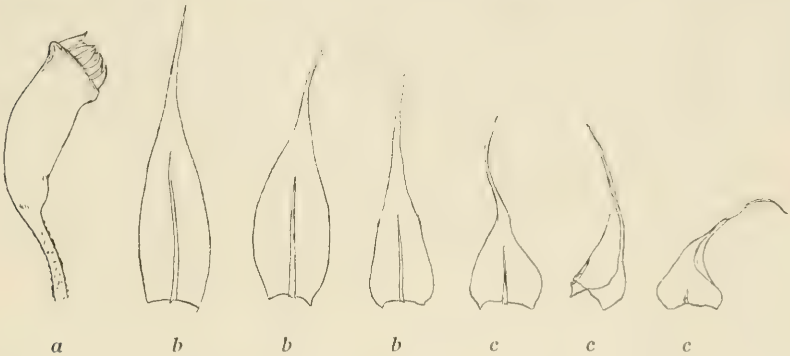


Fig. 15. *Brachythecium longipilum.* *a*, Capsule (× 20); *b*, branch-leaves (× 20); *c*, stem-leaves (× 20).

et tenuissimum recurvatum producta, per totam marginem denticulata, 1—1.2 mm. longa, 0.4—0.6 mm. lata, costa brevi et indistincta. Folia ramorum erecto-patentia aut subsecunda, lanceolata, longius acuminata, 1.4—1.6 mm. longa, 0.4—0.6 mm. lata, per totam marginem denticulata,

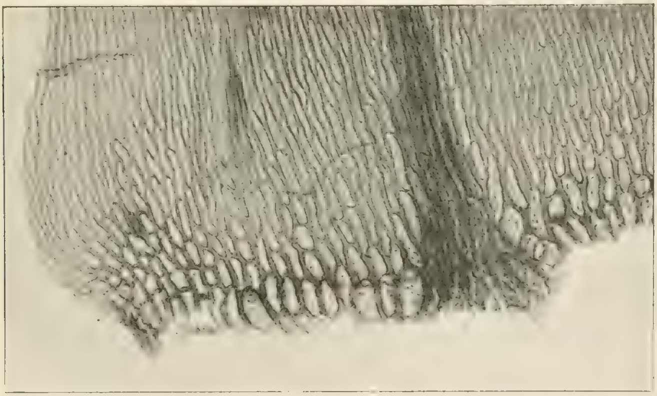


Fig. 16. *Brachythecium longipilum.* Leaf-base (× 175; phot.).

costa mediam partem folii paulo excedente. Cellulæ angustæ, sinuatæ, 0.004 mm. latæ, 0.060—0.075 mm. longæ, basilares in uno vel duo seriebus, ovales, porosæ, pachydermiæ, 0.010 mm. latæ, in angulis quadratæ vel ovales, paucæ.

Perichætium e cauli primario egressum. Folia perichætialia exteriora apice brevi, interiora apice longo reflexo, ecostata vel costa perbrevi et

indistincta, margine leniter dentato. Seta 8 mm. longa, c. 14 mm. crassa, purpurea, in dimidia parte superiori rugosa, inferne glabra. Capsula fusca, obliqua, longe ovata, operculata 1.7 mm. longa, 0.5 mm. crassa, deoperculata sub orificio contracta. Operculum conicum 0.6 mm. altum. Dentes peristomii 0.46 mm. longi, 0.067 mm. lati, pallide lutei, apicibus hyalinis, basi aurantiaci et leniter transverse striati. Sporæ 0.021— 0.024 mm., papillulosæ.

S. Iceland: Flokastadagil, on stones at the margin of the river. The capsules were empty in the middle of July.

249. **Brachythecium populeum** (Hedw.) Br. eur.

Hypnum populeum Hedw.

S. Iceland: Vik (H. J.)!, fr.; Drángshlid!, fr.

Grew in both the above localities on rather dry tuff rocks.

250. **Brachythecium velutinum** (L.), Br. eur.

S. Iceland: Thingvellir (Grl.)! ; Vik (H. J.)!; Holt!, in a cave at an altitude of about 300 metres, fr.

Near Thingvellir it grew in a lava-cleft, associated with *Blepharostoma trichophyllum*, *Plagiochila asplenioides* and *Plagiothecium silvaticum*.

251. **Brachythecium glaciale** Br. eur.

Hypnum glaciale C. Hartm.

N. Iceland: Akureyri!, at an altitude of 770 metres. NW. Iceland: Sugandafjördur!, at an altitude of 450 metres. W. Iceland: Dalasysla, Melár, on a cliff inhabited by sea-fowl (H. J.)!.

On damp gravelly flats. Near Sugandafjördur it grew abundantly, intermixed with *Hypnum stramineum*, *Mniobryum albicans* and *Philonotis fontana*, in cushions 3—4 cm. deep, on ground saturated by melting snow, and on stones. The plants were about 5 cm. long and irregularly branched with unequally long — mostly short — branches. The leaves were erectly spreading, not secund, and very longly decurrent with numerous quadrate, thin-walled cells at the basal angles of the leaves.

252. **Brachythecium reflexum** (Starcke) Br. eur.

Commonly distributed.

This species has its main distribution in gravelly spots on the rocky flat, especially on slopes and dry snowless patches on the mountain heights. It is especially abundant in NW. Iceland, where it is everywhere the most frequently occurring species on stony slopes. Here it is usually found associated with *Hypnum uncinatum*, *Lescuræa* spp., *Lophozia lycopodioides*, *L. Flœrckei*, etc., and is met with as high as about 500 metres above sea-level. In Esja, in SW. Iceland, it was common from about 200 metres upwards. In the low land it is rarer and appears

to occur more particularly in the lava-fields, for instance near Hafnarfjördur, Thingvallahraun and Kihlhraun. It is found rather frequently in fruit.

253. **Brachythecium glareosum** (Bruch) Br. eur.

Hypnum glareosum Bruch.

E. Iceland: Seydisfjördur, on stones!. N. Iceland: Tverá in Öxnadalur, on damp gravelly ground!. W. Iceland: Botnsdalur, damp rocks!.

254. **Brachythecium albicans** (Neck.) Br. eur.

Hypnum albicans Neck.

Commonly distributed over the whole of Iceland.

This species grows on a dry substratum, for instance on sandy or grass-covered ground, on soil-covered stones, on dikes and on the peat-walls of houses. It is most frequent in the low land up to a height of about 300 metres, but occasionally, for instance near Akureyri, it ascends as high as about 600 metres above sea-level. Only sterile specimens have been found.

255. **Brachythecium erythrorrhizon** Br. eur.

Hypnum erythrorrhizon Hartm.

N. Iceland: Hof near Eyjafjördur (O. D.)!; Ljosavatn!; Tverá in Öxnadalur!. W. Iceland: Esja!.

Found in all the localities only scantily intermixed in the tufts of other mosses on rather dry ground. Near Ljosavatn it grew in the *Betula nana* heath in association with *Hylocomium proliferum*, *Hypnum uncinatum*, *Heterocladium squarrosulum* and *Lophozia lycopodioides*; in Esja it grew on a slope with a southern exposure, in company with *Hylocomium* spp. and *Hypnum imponens*.

256. **Brachythecium rivulare** (Bruch) Br. eur.

Hypnum rivulare Bruch.

Very common over the whole of Iceland.

One of the most frequent mosses, which occurs everywhere on damp ground up to about 400—500 metres above sea-level. It occurs both in large and small streams, where it covers the stones or the gravelly soil along the banks with its extensive mats, and in bogs, and is also one of the species which is most frequently met with in moss bogs. Occasionally, however, it grows also on a more dry substratum, for instance on soil-covered rocks and among grass. Only sterile specimens have been found.

257. **Brachythecium latifolium** (Lindb.) Philib.

Hypnum latifolium Lindb.

Gjá near Alptagerdi (St.)!, in company with *Mnium punctatum*.

258. **Scleropodium purum** (L.) Limpr.

Hypnum purum L.

SW. Iceland: Álafoss!. S. Iceland: Breidabolstadr!; Barkardstadr!; Holt!; Drángshlid!; Skógafoss!.

This species has been found only in the southern part of Iceland, where it is frequent on Fljótshlid and below Eyjafjall. Near Álafoss it grew on the slope stretching down towards the river in which the temperature of the water was about 25°. Usually it grows at the foot of cliffs with a southern exposure, or in clefts, and, as a rule, in association with *Hylocomium* spp., *Eurhynchium piliferum*, *Mnium undulatum*, *Thuidium delicatulum* and *T. tamariscinum*.

259. **Eurhynchium strigosum** (Hoffm.) Br. eur.

Hypnum strigosum Hoffm.

Var. ***præcox*** (Hedw.) Lindb.

N. Iceland: Hof (O. D.)!; Vidimýri (Grl.)!. W Iceland: Kalmanstunga (Grl.)!; Gilsbakki!; Reykjavik!. S. Iceland: Barkarstadr!.

Grows everywhere rather scantily on dry soil-covered rocks or on tuff.

260. **Eurhynchium diversifolium** (Schleich.) Br. eur.

Hypnum strigosum var. *diversifolium* Lindb.

N. Iceland: Reykjahlid!; Hofsfjall near Eyjafjördur (O. D.)!; Akureyri, at an altitude of about 900 metres!.

Near Akureyri it grew in gravelly soil at the summit of the mountain, interspersed in tufts of *Sphærocephalus turgidus*, *Dicranum congestum* and *Hylocomium proliferum*. Near Reykjahlid it grew intermixed in a tuft of *Timmia austriaca*.

Eurhynchium præcox and *E. diversifolium* are so closely allied that, according to my opinion, it is doubtful whether the last species can be regarded as anything more than a decidedly Alpine form of *Eurhynchium strigosum*. The leaves in the plants determined as *E. diversifolium* are longly decurrent. The cells of the basal angles of the leaves vary considerably in number, even on the same plant, usually they are very numerous; but specimens of *E. strigosum* var. *præcox* from Central Europe also vary considerably in this respect, and often have many more alar cells than has the type.

261. **Eurhynchium cirrosum** (Schwägr.) Limpr.

Brachythecium cirrosum (Schwägr.) Schimp.

SW. Iceland: Esja!; Kolvidarhol!, at an altitude of about 300 metres.

In Esja it grew rather scantily on a damp slope, in company with *Hypnum chrysophyllum*. Near Kolvidarhol it grew abundantly on the ground among grass and species of *Carex*.

262. **Eurhynchium piliferum** (Schreb.) Br. eur.

Hypnum piliferum Schreb.

W. Iceland: Budahraun (H. J. !; Álafoss near Reykjavik!; Hafnarfjördur!. SE. Iceland: Hornafjördur!. S. Iceland: Reykirdalur!, up to about 150 metres above sea-level; Breidabolstadr!; Holt!, in several places up to about 300 metres above sea-level; between Thingvellir and Geysir (Grl.)!; common around Thingvellir!; Drángshlid!; Vestmannaey!.

Rather common in the South-western and Southern parts of Iceland. It usually grows in protected localities, for instance in lava-clefts, but occasionally, for instance near Reykir, it occurs on moss-grown slopes in company with *Hylocomium* spp. Near Thingvellir it was found abundantly in Almannagjá, at the grass-covered bottom of the ravine. Only sterile specimens have been found.

263. **Eurhynchium Swartzii** (Turn.) Curnow.

Hypnum Swartzii Turn.

S. Iceland: Drángshlid (H. J ;!); Merkjáfoss (F.)!; common on Fljótshlid and below Eyjafjall!; Reykirfoss!. SW. Iceland: Álafoss.

This species was found only in S. Iceland, but was common there on damp rocks, especially at the base of the sides of tuff rocks in clefts and in damp caves. Only sterile specimens have been found.

Note. *Eurhynchium hians* from Merkjáfoss leg Feddersen belongs to *E. Swartzii.*

Hypnum prælongum is recorded from Iceland by Zoëga. There are no specimens of it in the collections, but perhaps it has been confused with *E. Swartzii*

264. **Eurhynchium Stockesii** (Turn.) Br. eur.

Hypnum Stockesii Turn.

S. Iceland: Drángshlid!; Hrutafell!; Holt!; Seljaland!; Vestmannaey (H. J.;!).

Rather common south of Eyjafjall and on Vestmannaey. It usually grows rather scantily on the ground, between blocks of rock or in clefts. On Vestmannaey it occurred in several places; among other localities at the foot of cliffs, in company with *Mnium undulatum* and *Lophocolea cuspidata.* Only sterile specimens have been found.

265. **Rhynchostegium murale** (Neck.) Br. eur.

Hypnum murale Neck.

S. Iceland: Drángshlid!; Hrutafell!.

In the above localities it grew rather abundantly at the foot of dry tuff rocks and on fallen blocks. The fruit was ripe in the latter half of July, but some of the lids still persisted.

266. **Rhynchostegium rusciforme** (Neck.) Br. eur.

Hypnum rusciforme Neck.

N. Iceland: Near Eyjafjördur (O. D.)!. NW. Iceland: Isafjördur!. W. Iceland: Dalsmýnne in Nordredalur!; Lundurreykjadalur!; Esja!; Ellidará near Reykjavik!. S. Iceland: Tungufoss (F.)!; Vik (H. J.)!; Reykirdalur!, fr.; frequent on Fljótshlid and near Eyjafjall!.

Var. *atlanticum* Brid.

N. Iceland: Between Svinadalur and Dettifoss!; Husavik!. W. Iceland: Esja!, in several places. S. Iceland: Reykirdalur!; Holt!; Vik (H. J.)!.

The type is rather frequent in the Southern and Western parts of Iceland, rarer in North Iceland, and has not been found in East Iceland. It usually grows on wet rocks near waterfalls, or on stones in the rivers, as a rule rather scantily, and mixed with *Brachythecium rivulare*, *Hypnum ochraceum*, etc. Only in Reykirdalur did it occur abundantly in the river and on the rock-sides by the waterfall, also in fruit.

Var. *atlanticum* is found in swiftly flowing rivers, where it often covers the bottom and stones for long distances.

267. **Thamnium alopecurum** (L.) Brid.

W. Iceland: Dalasýsla, Vogur (H. J.)!; Jærngerdarstadr (Sæmundson)!. S. Iceland: Reykirdalur!; Paradishellir (Stp.)!; common on Fljóthlid and below Eyjafjall!.

On wet shady rock-faces and in caves. In S. Iceland it is common in the tuff-clefts, especially on the inwardly sloping surfaces, and in the numerous dark, damp caves, where it often covers the roof and sides through which water is percolating. Only sterile specimens have been found.

268. **Plagiothecium silvaticum** (Huds.) Br. eur.

N. Iceland: Grimsey (O. D.)!. S. Iceland: Thingvellir (Grl.;!); Almannagjá!.

In Almannagjá it was found scantily at the bottom of a lava-cleft. Only sterile specimens were found.

269. **Plagiothecium Roeseanum** (Hampe) Br. eur.

Syn. *Plagiothecium silvaticum* var. *Roesei* (Hampe) Lindb.

Commonly distributed, but as a rule rather scantily, in soil-filled rock-crevices, in company with *Mnium orthorrhynchum*, *Plagiochila*

asplenioides, *Pohlia cruda*, etc., up to about 300 metres above sea-level. Near Kolvidarhol and Seljaland it was found at an altitude of about 400 metres. Only sterile specimens have been found.

270. **Plagiothecium denticulatum** (L.) Br. eur.

N. Iceland: Mývatn (Grl.;!); Grimsey (O. D.)!; Hof (O. D.)!; Vidvik (P. Sófóniasson)!; Ásbyrgi!. NW. Iceland: Grunnavik!; Kaldalon!. W. Iceland: Gilsbakki!; Hafnarfjördur!; Reykjavik!. S. Iceland: Thingvellir!; Holt!; Vestmannaey!.

Found here and there on humus-covered rocks or in lava-clefts, but everywhere scantily only, and sterile.

Recorded by König and Steenstrup from Iceland, but there are no specimens of it in the collections.

Plagiothecium undulatum is recorded by Lindsay and *P. silesiacum* by Hornemann (from Geysir), but no specimens of either of these two species are to be found in the collections, so the determinations are undoubtedly erroneous.

271. **Plagiothecium pulchellum** (Dicks.) Br. eur.

Isopterygium nitidum v. *pulchellum* Lindb.

Iceland (Mörch). Commonly distributed over the whole of Iceland.

Grows in rock-crevices, caves, lava-clefts, etc.; either in small unmixed tufts or, more often, intermixed with other mosses. It does not appear to ascend higher than about 400 metres above sea-level and, as a rule, sets fruit.

The majority of the plants which have been investigated belong to the type. Var. *nitidulum* Wahlb. (L. et J. *Isopterygium nitidulum* Lindb.) is far rarer, and grows by preference especially in deep shade; but, for the rest, this form is not very characteristic and passes without limit into the type.

272. **Plagiothecium depressum** (Bruch) Dixon.

S. Iceland: Holt!; Vestmannaey, Heljusdalur!.

In Heljusdalur it grew in masses on a talus of fallen blocks and debris (Urd), everywhere covering the ground between the large blocks with its brightly shining mats. Near Holt it was found mixed with *Brachythecium velutinum* at the bottom of a tuff cave at an altitude of about 300 metres.

273. **Plagiothecium elegans** (Hook.) Sull.

Isopterygium elegans (Hook.) Lindb.

S. Iceland: Reykirdalur!, at an altitude of 260 metres.

It was growing here on warm soil in the neighbourhood of a sulphur spring, on the ground below a projecting block of rock, in company with *Diplophyllum albicans* and *Pellia Neesiana*.

The form found is robust, light green, highly shining and differs in habit by the leaves being very decidedly two-rowed, spreading. Gemmæ, which were, by the by, quite typical, occurred only extremely few in number.

274. **Amblystegium Sprucei** (Bruch) Br. eur.

Commonly distributed over the whole of Iceland.

Grows in rock-clefts, dark ravines and caves, and among fallen blocks of rock, usually scantily woven into the tufts of other mosses such as *Plagiothecium pulchellum*, *Amphidium Mougeottii*, *Lophozia Mülleri*, *L. heterocolpos* and *Mnium orthorrhynchum*, but occasionally also in tiny cushions or as delicate, cobweb-like coverings on roofs in caves. In Esja it was found up to about 400 metres above sea-level. Only sterile specimens have been found.

275. **Amblystegium fluviatile** (Sw.) Br. eur.

SW. Iceland: Tungufoss (F.)!, determined by C. Jensen.

Only a few stems were found, intermixed with other mosses, for instance *Brachythecium rivulare*, *Hypnum ochraceum*, etc.

276. **Amblystegium serpens** (L.) Br. eur.

N. Iceland: Akureyri, fr. (Grl.)!; Mývatn, fr. (Grl.)!. W. Iceland: Reykjavik!, Vestmannaey!, fr.

In Iceland this species is as variable as it is in other places. The specimens from Myvatn were very robust, with leaves 1.33 mm. long and 0.65 mm. broad, erectly spreading, and distinctly toothed in their lower half, with rather long and strong nerve, and cells 0.010—0.012 mm. broad and 4—6 times as long. Near Reykjavik it grew in large cushions, 1—2 cm. deep, on a stone wall near the sea-side. In the plant from the latter locality the leaves were broadly ovate, longly pointed and almost entire at the margin, with cells 0.009—0.011 mm. broad and 2—3 times as long. The form from Vestmannaey is very slender, with leaves 0.7 mm. long and 0.3 mm. broad, with very short nerve which in the branch leaves was just indicated immediately above the leaf-base. On Vestmannaey the fruit was quite unripe on July 6th; in N. Iceland it was ripe at the end of July.

277. *Subsp. **Amblystegium Juratzkanum** Schimp.

N. Iceland: Fagriskogur (St.)!. S. Iceland: Drángshlid!, fr.; Vestmannaey!.

The plant from Drángshlid was quite typical and bore ripe capsules at the end of July. The specimens which were collected on the base of a birch-trunk in Fagriskogur agreed fairly well with the form described by Limpricht (Kryptogamenflora, vol. III, p. 323) under the name of *Amblystegium radicale*. The leaves taper from an ovate-lanceolate base

to a very long and slender point, and are about 1 mm. long and 0.1 mm. broad. The branch leaves are lanceolate and toothed along their entire margin, with short nerve. The cells at the base of the leaf are quadrate, yellow and rather thick-walled, 0.012—0.015 mm. broad; those in the upper half of the leaf narrowly prosenchymatous, 0.08 mm. broad, and 6—8 times as long, and often somewhat wavy.

278. Subsp. * **Amblystegium littorale** (C. Jens.) Hesselbo.

Syn. *Amblystegium serpens* var. *littoralis* C. Jens. in "Færöernes Mosser".

N. Iceland: Grimsey O. D.!. W. Iceland: Reykjavik!; Brjanslækur (H. J.)!.

Both the plants agreed exactly with the specimens collected by C. Jensen in the Færöes. *A. littorale*, which is a Sub-arctic-Arctic form, is probably widely distributed. It has been found not only in the Færöes and in Iceland but also on Jan Mayen (Dusén) and in Sweden, on Gislö near Troså (Arnell). It has as yet been found sterile only.

279. **Amblystegium compactum** (C. M.) Br. eur.

Vestmannaey (H. J.;!). SW. Iceland: Öndverdarnes, in a well together with *Trentepohlia aurea* (H. J.)!.

On Vestmannaey this species occurred rather frequently on the sides of clefts and caves in tuff rocks. It grew there in company with *Trentepohlia*, especially in places where water was percolating through, and occurred sometimes in compact cushions several cm. deep, sometimes as a thin covering. The Iceland specimens agree exactly with North American plants of *A. compactum*; occasionally, however, the leaves especially of the forms growing as thin coverings are somewhat broader, with shorter cells.

W. Mönkemeyer and L. Loeske (Revision einiger Amblystegien aus dem Herbare Limpricht; Ungarischen bot. Blätter, 1911, p. 273) refer *Amblystegium salinum* Bryhn to *A. compactum* as var. *salinum* (Bryhn) Mkm. On investigating numerous specimens of *A. salinum* I have, however, arrived at the conclusion that these two species are in no way connected with each other. *Amblystegium compactum* forms compact, dark-green tufts with a somewhat silky lustre, closely interwoven in the interior with rusty brown rhizomes which proceed partly from the stem and partly, in very great numbers, from the under side of the stem-leaves. The stem is prostrate with apex rising upward, and with numerous branches. The leaves are very close-set, longly decurrent, erectly spreading and secund. The stem leaves taper from a broadly ovate base to a long and slender point with strongly curved back apex. The branch leaves are narrowly lanceolate, often with apex curved. The leaf-margin is sharply toothed along its entire length, and especially the lowermost teeth are often turned outwards or towards the base. In the branch leaves the nerve reaches to the apex and is of almost equal width along its entire length, straight, or sometimes slightly sinuous. The leaf-cells are narrower than in any other *Amblystegium*, 0.005—

0.006 mm. broad, and 6—10 times as long, thin-walled, pointed and wavy. On the whole, both the cell-tissue of the leaf and the form of the leaf-teeth call to mind far more an *Eurhynchium* or a *Rhynchostegium* than an *Amblystegium*.

Amblystegium salinum Bryhn grows in loose, yellowish green, hardly tomentose tufts. Rhizoids occur only on the lowermost part of the stem and scantily on the back of the nerve. The stems are erect or ascending, slightly and irregularly branched. The leaves are far more distant than in *A. compactum*, are spread out almost horizontally, very longly decurrent, ovate-lanceolate, with long, often somewhat obtuse apex; all are similar or the branch leaves are somewhat narrower. The leaf-margin is finely and obtusely toothed till towards the apex. The leaf-cells have the appearance typical of *Amblystegium*, and in the upper half of the leaf are 0.008 mm. broad and 4—6 times as long, with sinuose primordial utricle (the latter is usually wanting in *A. compactum*). The nerve is green and sinuose (as in *A. varium*) and vanishes just below, or in, the leaf-apex itself. *A. salinum* is undoubtedly a true *Eu-Amblystegium* which is nearest allied to *A. serpens*, but also approaches certain forms of *A. varium* (Hedw.) as regards the form of the basal cells of the leaf and the long sinuous nerve. It would also be remarkable if a species like *A. compactum*, which in North America grows on rocks and on damp ground in woods in the interior of the country, should in Europe turn into a decidedly salt-soil plant. *A. salinum* has been collected in many places along the coasts of Sweden and Norway; first by Zetterstedt on Öland and near Bosekop in Finmarken, and in the herbarium is named by him *Amblystegium serpens* var. *littorale*. Hagen has collected the same species in Salten in Nordland (65° 15′ N. lat.), where it was growing in company with *A. littorale* (C. J.), and in a letter he named it *Amblystegium breve* n. sp. On the other hand, it is not known to me that the real *A. compactum* has been collected in Scandinavia. I have not seen the *A. compactum* from salty soil in North Germany mentioned by Loeske (loc. cit. pp. 272—273), nor have I seen Mönkemeyer's *A. compactum* from Bornholm.

280. **Amblystegium salinum** Bryhn.

Vestmannaey! on damp sandy soil near the coast, sterile.

281. **Amblystegium trichopodium** (Schultz) Br. eur.

N. Iceland: Grimsey (O. D.)!.

Judging from the plentiful intermixture of Green Algæ, the plants from the above locality must have been growing on wet, probably muddy ground. ♂ and ♀ flowers were present in great numbers; fruit, on the other hand, had not been developed. The stem leaves were rather close-set, horizontally out-spreading, from an ovate base tapering to a long and slender point, finely toothed along the entire margin, 1.2—1.5 mm. long and 0.50—0.55 mm. broad, with green nerve, 0.04—0.045 mm. wide. The branch leaves were lanceolate, 0.95 mm. long and 0.30—0.35 mm. broad, with short green nerve. At the base of the leaf the cells were

green and rectangular, 0.018 mm. broad and 0.070 mm. long, in its upper half, 0.010 mm. broad and 4—7 times as long, with sinuous primordial utricle.



Fig. 17. *Amblystegium trichopodium* (Schultz). Habit (× 3).

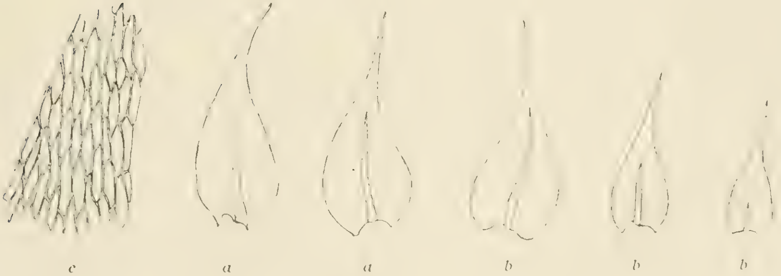


Fig. 18. *Amblystegium trichopodium* (Schultz) Br. eur. *a*, Stem-leaves and *b*, branch-leaves (× 20); c, leaf-cells near margin (×120).

282. **Hypnum Sommerfeltii** Myrin.

N. Iceland: Stora Brekka near Eyjafjördur (O. D.)!. S. Iceland: Fell (Harder, 1908)!, a few stems among *Hypnum uncinatum, H. stellatum* and *Ditrichum flexicaule*.

283. **Hypnum chrysophyllum** Brid.

Amblystegium chrysophyllum (Brid.) Lindb.

E. Iceland: Berufjördur!. N. Iceland: Near Mývatn (Grl.)!; Hof near Eyjafjördur (O. D.)!. W. Iceland: Esja, several places (Grl.;!). S. Iceland: Geysir, on warm ground!. Vestmannaey, Heljusdalur!.

Var. *β tenellum* Schimp.

W. Iceland: Esja!.

On damp gravelly ground and on rocks, rather rare and scanty. Near Geysir it grew plentifully on warm damp ground over which the tepid water from the basin was flowing. Only sterile specimens have been found.

Hypnum Zemliæ C. Jensen, which was collected by Steenstrup (but no habitat is given) is only a form of *Hypnum chrysophyllum*.

284. **Hypnum protensum** Brid.

Amblystegium protensum Lindb.

E. Iceland: Skreiddalur!; Seydisfjördur!. N. Iceland: Hof (O. D.)!; frequent in Esja!.

This species is probably widely distributed, but, on account of its great resemblance to the far more commonly occurring *H. stellatum*, cannot always be kept distinct from the latter species. It grows in somewhat damp localities, both on stones and on the ground, but only sterile specimens have been found.

285. **Hypnum stellatum** Schreb.

Amblystegium stellatum (Schreb.) Lindb.

Very common everywhere on a damp substratum, on rocks, on the ground and in bogs, and not rarely in fruit. It is abundant even at a height of 500—600 metres above sea-level.

286. **Hypnum polygamum** (Br. eur.) Wils.

Amblystegium polygamum Br. eur.

Very common on wet, boggy ground. It occurs especially abundantly in the neighbourhood of the coasts, but is also very common in the valleys further inland, and hardly ascends higher than about 300 metres. Fruit, which is met with very frequently, ripens at the end of June or in the beginning of July.

287. **Hypnum intermedium** Lindb.

Amblystegium intermedium Lindb.

This species is no doubt common, at least in N. Iceland, where it occurs around Eyjafjördur up to about 500—600 metres above sea-level. Only sterile specimens have been found.

288. **Hypnum revolvens** Sw.

Amblystegium revolvens De Not.

Very common over the whole of Iceland.

One of the most frequent and abundantly occurring mosses, which often forms the bulk of the vegetation in the bogs, both in the low land and in the Alpine region where it is plentiful even at an altitude of about 600 metres, for instance near Eyjafjördur. Fruit, which is often present abundantly, ripens in the beginning of July.

Hypnum revolvens is distinguished from *H. intermedium* only by the fact of its being monoicous. Therefore, in cases of the frequently occurring quite sterile plants, it is really impossible to decide whether they belong to the one or to the other species. This is especially true of the vigorous, slightly branched aquatic forms, which had previously been referred to *Hypnum Cossoni* Schimp. Both *H. revolvens* and *H. intermedium* form such *Cossoni*-forms, but as they are mostly quite sterile it is impossible to determine them with any certainty.

289. **Hypnum uncinatum** Hedw.

Amblystegium aduncum (L.) Lindb.

Very common everywhere upwards to the limit of plant-growth.

Var. ***orthothecioides*** (Lindb.).

N. Iceland: Grimsey (O. D.)!. NW. Iceland: Arngardareyri!; Grunnavik!. E. Iceland: Kirkjubol (H. J.)!.

Hypnum uncinatum is one of the most common mosses and occurs everywhere both on dry and on damp substrata, on earth, on rocks, in bogs, etc.; and often in such quantities that it is the most abundant constituent of the moss-carpet. It varies exceedingly in size, habit and colour. *Hypnum orthothecioides* cannot be maintained as species; in addition to the forms found in the above-mentioned habitats, others forming all possible transitions to the type have been found in many other localities. Fruit, which is rather common, ripens in the first half of July.

290. **Hypnum Sendtneri** Schimp.

Amblystegium Sendtneri (Schimp.) De Not.

N. Iceland: Helgavatnsfloi (Stp.)!.

291. **Hypnum Kneiffii** (Br. eur.) Schimp.

Amblystegium Kneiffii Br. eur.

This species is common, especially in N. and E. Iceland, and is somewhat rarer in NW. and S. Iceland. It grows in very wet situations in bogs, in pools, along the banks of rivers or covering stones in the water.

Aquatic forms with slightly secund, longly pointed leaves are frequent: short and broad leaved orthophyllous or drepanophyllous forms occur more rarely. The size of the leaf-cells is dependent on the form of the leaf; in f. *brevifolia* they are short in the middle of the leaf, about 3—4 times as long as they are broad. In Esja a brevi-orthophyllous form was collected in a moss-bog at an altitude of 410 metres.

It has been collected in fruit only near Husavik in N. Iceland.

292. **Hypnum exannulatum** (Gümb.) Br. eur.

Amblystegium exannulatum De Not.

Very common.

Hypnum exannulatum occurs in numerous forms everywhere on a damp substratum, often forming the bulk of the vegetation, either alone or mixed with other *Hypnaceæ* (*H. stramineum, H. revolvens*, etc.), with *Cinclidium, Mnium* spp., and other bog mosses. It grows not only in bogs, but also in pools, moss-bogs, along streams, and occasionally on damp rocks. Near Akureyri it was abundant even at an altitude of 600 metres.

Var. ***purpurascens*** (Schimp.) (*Hypnum purpurascens* Limpr.) is the most frequent form, at any rate in N. and E. Iceland. It is usually purplish, more rarely green, erect, as much as about 20 cm. high, and often forms large, pure growths on very wet ground, especially in the water itself, for instance along the banks of small streams. In this form the leaf-base is never decurrent. In the plants which have been investigated the cells of the leaf-base are sometimes quite typical, forming a single row of large dilated cells across the entire leaf-base, and sometimes they approach those of the type by forming a more or less large, triangular group of empty cells towards the leaf-margin. In typical *Hypnum exannulatum* the leaves are always narrowly decurrent.

Var. ***Rotæ*** (De Not.) is without doubt an extreme aquatic form of var. *purpurascens*, with which it is closely connected by intermediate forms. It has the solid, tough stem with long, forwardly directed branches and very narrow, slightly secund leaves peculiar to all mosses growing in swiftly flowing water. The nerve is very strong, usually 0.10 mm. wide at the base and, as a rule, vanishing in the apex, more rarely excurrent. It grows in running water, often in streams flowing through boggy ground. Typical specimens were collected in the following localities: E. Iceland: Seydisfjördur!, rather common; Breiddalskard!; Frodarheidi (H. J.)!. NW. Iceland: Kaldalon!; Dýnjandi!. W. Iceland: Hvammur (Grl.)!; Esja!, at an altitude of 100 metres. Only sterile specimens have been found.

Var. ***serratus*** (Warnst.).

Isafjördur!, in pools.

In *H. exannulatum* the length of the leaf-cells varies according to the shape of the leaf. In the most commonly occurring forms with longly pointed leaves the cells are narrow, 6—10 times as long as broad, while short-leaved forms have leaf-cells which are only 4—6 times as long as broad (var. *brachydictyon* Ren.), such forms are especially met with on cold, wet gravelly ground. Fruit is rather frequent, both in the type and in var. *purpurascens,* and ripens at the end of July.

293. **Hypnum fluitans** (Dill.) L.

Amblystegium fluitans (L.) De Not.

S. Iceland: Breidabolstadr (F.)!; Breidamerkursandur (Harder)!. N. Iceland: Blejkjuholt (St.)!; Mývatn (Grl.)!.

Monoicous forms, which may be referred to *H. fluitans* occur only very scantily and rarely in Iceland. The numerous older records of the occurrence of this species (Vahl, Mörch, Hornemann, Grönlund, etc.) are, without exception, due to erroneous determinations, and all the older specimens in the collections (except one) belong to *H. exannulatum* or *H. Kneiffii.*

H. fluitans grows everywhere in pools or on inundated ground. Near Blejkjuholt Stefánsson has collected a very peculiar form, with erect, obtuse leaves with short nerve. The cell-tissue of the leaves is very loose, and the cells of the leaf-base differ only slightly from the other cells.

Var. ***falcatum*** Schimp. (*Hypnum H. Schultzii* Limpr.)

This very characteristic form was found abundantly, and in fruit, on wet boggy ground near Kaldalon in NW. Iceland.

294. **Hypnum filicinum** L.

Amblystegium filicinum (L.) De Not.

Very common.

In the greater part of Iceland this species is one of the most frequent mosses on a damp substratum, especially on wet rocks, but also on gravelly ground and in bogs. In most part of N. Iceland it is somewhat rarer, and usually occurs more scantily. In S. Iceland it often covers the faces of wet tuff-rocks in enormous mats and not rarely sets a great quantity of fruit. In the rest of Iceland fruit is rarer and occurs most often in the large, tomentose bog-form. In S. Iceland fruit was ripe in the middle of July.

Hypnum filicinum varies exceedingly. Bog forms and forms from wet gravelly ground are usually densely tomentose and regularly pinnately branched. Rock forms, when growing on a more dry substratum, are slender and slightly branched; on wet rocks, especially on tuff, very large and vigorous, often almost like *Hypnum commutatum.*

H. filicinum has its main distribution in the lowlands up to about 300 metres above sea-level, but is also frequently met with, for instance near Berufjördur and in Esja, up to a height af about 500 metres. At this altitude it grows on rocks in low, dense cushions, more rarely on wet gravelly ground, and these Alpine forms constitute a distinct transition to *H. curvicaule* Jur., which is perhaps only a High Alpine form of *H. filicinum*.

295. **Hypnum curvicaule** Jur.

Amblystegium curvicaule (Jur.) Dicks. & James.

E. Iceland: Berufjardarskard!, 540 metres above sea-level; Seydisfjördur!, frequent from about 100—500 metres above sea-level. W. Iceland: Mödruvellir!, about 400 metres above sea-level.

Grows on damp gravelly ground and rocks on mountain heights up to 500—600 metres. On dry rocks the leaf-cells become longer and narrower and the alar cells more thick-walled. Near Seydisfjördur it was collected with quite young fruit (3. 7. 1909).

296. **Hypnum decipiens** (De Not.) Limpr.

Amblystegium glaucum β. decipiens Lindb.

E. Iceland: Very common near Seydisfjördur!; Dvergasteinn (H. J. !) N. Iceland: Husavik!; Ljosavatn!; Akureyri!; Öxnadalur!. W. Iceland Brattabrekka!.

Common from Seydisfjördur in E. Iceland throughout the whole of N. Iceland. The westernmost habitat of this species is Brattabrekka, south of Haukadalur. In the rest of Iceland it has not been observed.

Hypnum decipiens grows on very wet, especially gravelly, ground, for instance at the edge of moss-bogs or on inundated gravelly ground, and along small streams both on the ground and on stones. It hardly ascends higher than about 300 metres, and rarely sets fruit. Near Seydisfjördur, Husavik and Tverá in Öxnadalur it was collected in fruit.

297. **Hypnum commutatum** Hedw.

Amblystegium glaucum (Lam.) Lindb.

E. Iceland: Seydisfjördur (H. J.;!). N. Iceland: Husavik!; Reykjahlid!. W. Iceland: Lundur!; rather frequent in Esja!. S. Iceland: Rather common!.

Var. ***falcatum*** (Brid.) C. M. *Hypnum falcatum* Brid.

Very common.

H. commutatum is the more rarely occurring form. It is most frequent in SW. and S. Iceland, where it is especially abundant on wet tuff-rocks. It is rather rare and scanty everywhere else in Iceland.

Var. *falcatum*, together with all possible transitions to the type, is one of the most common mosses in the greater part of Iceland. Only in NW. Iceland is it scanty and met with only here and there. Both

forms grow on rocks in and by the water, on wet rock-faces and on the ground, both on wet gravelly ground and on the ground in bogs. It often forms, especially in N. Iceland, an essential part of the moss-carpet in bogs. It hardly ascends higher than about 300 metres above sea-level. ♀ plants are very common, ♂ plants and fruit are far rarer. It has been found in fruit near Stafafell, Seydisfjördur, Hrutafjördur and, rather frequently, in S. Iceland (both forms).

298. **Hypnum molluscum** Hedw.

Ctenidium molluscum (Hedw.) Schimp.

Iceland (Mörch)!; Bardshellir (Grl.)!; Brynjudalur (Grl.)!. W. Iceland: Common near the hot springs in Reykholtdalur!; Botnsdalur!; common about Reykjavik!; common in Esja!; Kolvidarhol!, up to about 350 metres above sea-level. S. Iceland: Very common!. SE. Iceland: Hornafjördur!.

This species is very common in S. Iceland, especially on Fljótshlid and about Eyjafjall, but is also plentiful near Thingvellir, and frequent in SW. Iceland as far as Borgarfjördur, where it is, however, chiefly confined to the warm ground. It appears to be quite absent from the other parts of Iceland.

H. molluscum grows on a damp substratum, both on damp rocks, especially tuff, and on damp ground. Near Thingvellir it grew abundantly, covering the blocks at the bottom of the large lava-clefts. Around the hot springs in SW. and W. Iceland it occurs abundantly in several places. Thus in Reykholtdalur it is one of the most frequent species of the warm clayey flats.

It occurs almost exclusively in the low land, and only near Kolvidarhol was it found about 350 metres above sea-level. Only sterile specimens have been found.

299. **Hypnum imponens** Hedw.

Stereodon imponens (Hedw.) Brid.

E. Iceland: Hof, on basalt rocks!. W. Iceland: Esja!; Braudarholt!. N. Iceland: Vidimýri, near a hot spring (Grl.)!. W. and SW. Iceland: Near almost all the hot springs!.

In SW. and W. Iceland it grew with a few exceptions on warm ground. In Esja it grew in company with *Camptothecium lutescens* on a grass-covered slope, and near Braudarholt intermixed with other *Hynaceæ* on the top of knolls in bogs.

On a warm substratum *Hypnum imponens* grows especially on the drier clay-flats; there it often forms extensive mats, partly alone, partly mixed with *Hypnum stramineum*, *H. Lindbergii*, *H. molluscum*, *Hylocomium squarrosum* and other species. Only sterile specimens have been found.

300. **Hypnum Bambergeri** Schimp.

Stereodon Bambergeri (Schimp.) Lindb.

W. Iceland: Breidabolstadr in Reykholtdalur!.

It was growing there on a damp gravelly flat in company with *Ditrichum flexicaule, Myurella julacea, Tortella tortuosa* and *T. fragilis.*

301. **Hypnum revolutum** (Mitt.) Lindb.

Stereodon revolutus Mitten.

Very common over the whole of Iceland.

It grows both on dry and on more or less damp rocks, occasionally also on gravelly soil, and is frequent up to about 600—700 metres above sea-level. It varies considerably in size, from quite slender forms for instance on lava blocks to very robust forms on damp stones in clefts. Fruit, which was ripe in the middle of July (but the lids still persisted), was found only near Breidabolstadr in S. Iceland, where *Hypnum revolutum* grew in deep cushions, covering stones in a cleft.

302. **Hypnum cupressiforme** L.

E. Iceland: Berufjördur (Grl.;!); Hof!; Hornafjördur!. N. Iceland: Vidvik near Skagafjördur (P. Sófóniasson)!; Vidimýri!; common west of Blóndudalur!. W. Iceland: Stykkisholmur!; Botnsdalur!; common about Esja, Hvalfjördur, Reykjavik and Hafnarfjördur!. S. Iceland: Common!. Vestmannaey!.

Common from Berufjördur in E. Iceland throughout S. and W. Iceland and the western part of N. Iceland to Blóndudalur. In E. Iceland it has not been found further northwards than Berufjördur, and in NW. Iceland it has not yet been observed. East of Hunafloi it has been found only in a few localities near Skagafjördur.

It usually grows on rather dry rocks or on soil-covered rock-ledges, and does not appear to ascend higher than about 300 metres above sea-level. Only sterile specimens have been found.

Var. *ericetorum* is recorded from Ormarstadir in E. Iceland (leg. H. J., det. C. Jensen), but there are no specimens of it in the collections.

303. **Hypnum hamulosum** Br. eur.

Stereodon hamulosus Lindb.

E. Iceland: Hof!, at an altitude of 100 metres; Hornafjördur!. W. Iceland: Esja, Mödruvellir!, on tuff rocks, 250—400 metres above sea-level; Kolvidarhol!; common on tuff, from 250 to 450 metres. NW. Iceland: Grunnavik!, at an altitude of about 280 metres. S. Iceland: Holt!; Drángshlid!. Vestmannaey!.

Rather frequent in the South-western and South-eastern parts of Iceland. It has been found almost everywhere on tuff-rocks, where it

occurred abundantly in several places, for instance in Esja, but only sterile specimens were found.

304. **Hypnum callichroum** (Brid.) Br. eur.

Stereodon callichrous Brid.

E. Iceland: Seydisfjördur!. NW. Iceland: Common everywhere!. W. Iceland: Budahraun (H. J.!; Grundarfjördur (H. J.!; common everywhere in the lava-fields east of Reykjavik and around Hafnarfjördur!; Svinahraun!; Esja, in *Grimmia*-heath at an altitude of about 400 metres, and in many places along the banks of streams!. S. Iceland: Skálholt!; Thingvellir!; Holt!, common on tuff-slopes in clefts.

This species is common in the south-western part of Iceland, and very common in North-west Iceland. In North Iceland it has not been found, and in East Iceland only near Seydisfjördur. It occurs in Iceland in two forms. The most frequent form is the typical bog-soil form, which is exceedingly common especially in NW. Iceland, and sometimes forms the bulk of the vegetation in damp situations, especially along streams, on wet slopes and at the edge of bogs, usually in association with *Harpanthus*, *Lophozia quinquedentata*, *Cephalozia bicuspidata*, etc. Around Isafjördur it occurs up to a height of about 300 metres, and in S. and SW. Iceland up to almost 500 metres above sea-level.

Everywhere in the depressions and at the bottom of the clefts of the lava-fields of South-western and West Iceland a mesophilous form is found, which is distinguished by its size and by its almost regularly two-rowed ramification. It grows in deep, loose and soft cushions, either among grass or mixed with *Hylocomium* spp., *Rhacomitrium hypnoides* and species of *Dicranum* and of *Lophozia*.

Fruit was collected only in Kaldalon in NW. Iceland; it was quite undeveloped even at the end of June.

305. **Hypnum Lindbergii** Mitten.

Stereodon arcuatus Lindb.

Very common.

This species grows on wet ground, especially in bogs, associated with *H. revolvens*, *H. cuspidatum*, *Hylocomium squarrosum*, *Meesea*, etc.; but also on damp gravelly ground and on soil-covered rocks. It appears to be of almost equal frequency everywhere. Near Berufjördur it was collected up to a height of about 500 metres above sea-level, and on Eyjafjall in S. Iceland it was frequent at the same height. Near Akureyri it occurred abundantly on boggy ground even at an altitude of 500-600 metres. Only sterile specimens have been found.

Hypnum pratense is recorded by Grönlund from several localities, but the record is due to a confusion with *H. Lindbergii*.

Note. *Hypnum incurvatum* is recorded from Iceland by Mörch, but the specimens in his collection belong to *Plagiothecium pulchellum*.

306. **Hypnum palustre** Huds.

Amblystegium palustre (Huds.) Lindb.

E. Iceland: Seydisfjördur!. N. Iceland: Akureyri (Grl.)!; Vidimýri (Grl.)!; Grímstunga (Grl.)!; Ljosavatn!, at an altitude of about 300 metres; Melar (Grl.)!. W. Iceland: Gilsbakki!; Reykholtdalur (Grl.;!); Lundurreykjadalur!; Reykjavik!; common in Esja!; Alafoss!. S. Iceland: Common!.

This species is common in S. Iceland (Eyjafjall, Fljótshlid, etc.), SW. and W. Iceland, is found here and there in N. Iceland and is rare in E. Iceland. It has not yet been found in NW. Iceland. It grows everywhere on rocks and stones in and by rivers, and almost always sets fruit, which ripens during July. It does not appear to ascend higher than about 300 metres above sea-level.

Of the varieties only var. *δ subsphæricarpon* (Schleich.) Br. eur. is of any interest. It occasionally occurs in company with the type on stones in swiftly flowing rivers.

307. **Hypnum arcticum** Sommerf.

Amblystegium Smithii (Sw.) Lindb.

W. Iceland: Hvammur (Grl.)!. NW. Iceland: Bæir! fr. It is, moreover, recorded from Iceland by Mörch and from Akureyri (Grl.), but both the plants are wrongly determined.

Near Bæir it grew on wet rocks by a small waterfall.

308. **Hypnum alpestre** Sw.

Amblystegium rivulare (Sw.) Lindb.

E. Iceland: Berufjördur!, common; Seydisfjördur!, common up to about 200—300 metres above sea-level; Breiddalskard!, at an altitude of about 400 metres; Vallanes (H. J.;!), common on rocks along the sea; Skriddalur!. N. Iceland: Öxnadalur!, very common in the river. NW. Iceland: Isafjördur!, frequent up to about 200 metres; Sugandafjördur!; Arngerdareyri!. W. Iceland: Lundur!. SW. Iceland: The Laxá (F.)!; the Langá (H. J.)!; the Öxarará!.

Common in E., N. and NW. Iceland, rarer in W. and SW. Iceland. This species has its main distribution in E. Iceland, where it occurs everywhere in the rivers and often covers the stones along the banks for long distances. Fruit, which occurs rather commonly, ripens in July (Öxnadalur, July 24; Vallanes, hardly ripe on June 28th).

309. **Hypnum alpinum** Schimp.

Amblystegium molle β alpinum Lindb.

E. Iceland: Berufjördur!. N. Iceland: Akureyri (Grl.;!); Hof near Eyjafjördur (O. D.)!; Holar (Grl.)! fr.; Lækjarmot! fr.; common in Öxnadalur! fr.. NW. Iceland: Isafjördur! fr.; Dýrafjördur! fr.; Arngardareyri! fr.; Dýnjandi! fr.

Figured in Flora Dan. tab. 2621, fig. 2 as *Hypnum molle*, leg Mörch.

This specimen is not to be found in the collections: on the other hand, a specimen from Iceland, determined by Mörch as *Hypnum arcticum*, belongs to *H. alpinum*.

Rather common in N. and NW. Iceland, where it grows on stones in rivers, like the other species of *Hygrohypnum*. It does not ascend higher than about 200 metres above sea-level (Isafjördur), and often sets fruit which ripens in N. Iceland in the latter half of July.

Hypnum alpinum varies considerably in leaf-form, leaf-tissue and habit.

The leaves, which are most often spreading, are occasionally falcato-secund along the entire length of the stem, in which feature it approaches *H. dilatatum* in habit. The Iceland specimens of *H. alpinum* approach, on the whole, *H. dilatatum*, both in habit, leaf-form and structure of cell-tissue. The cells of the base of the leaves are often thickened and slightly porous, and the alar cells are sometimes colourless and thin-walled, sometimes yellowish with slightly thickened walls. The leaf-form varies from almost orbicular to elliptic. The leaf-margin is almost always finely toothed all round.

I have, however, thought it more correct to refer all the Iceland plants to *H. alpinum*, as at any rate the capsule and the perichætium corresponded exactly to those in this species. Thus, fully developed cilia have never been found in the peristome. The leaf-cells are also shorter than in *H. dilatatum* and in size agree most nearly with those in *H. alpinum*.

310. **Hypnum ochraceum** Turn.

Amblystegium ochraceum Lindb.

Very common on stones in rivers up to 300—400 metres above sea-level, but only sterile specimens have been found.

Varies considerably in size, habit, etc.

Var. ***uncinatum*** Milde often occurs in company with the type.

Var. ***filiforme*** Limpr. is rather common in swiftly flowing rivers, where it often covers the bottom for long distances.

Note. *Amblystegium polare* Lindb. is recorded by Grönlund (Tillæg til Islands Kryptogamflora, Bot. Tids., 20, p. 113) to have been collected near Vallanes by H. Jónsson. The specimen in question is in the Botanical Museum in Copenhagen and is labelled "*Dichodontium pellucidum, Polytrichum alpinum, Amblystegium polare*, det. C. Jensen", but in spite of a careful search it was not possible to find *A. polare* among the specimens, so for the present the occurrence of this species in Iceland must be regarded as uncertain.

311. **Hypnum cordifolium** Hedw.

Amblystegium cordifolium De Not.

N. Iceland: Mývatn (Grl.)!. NW. Iceland: Grunnavik!, fr.

This species is also recorded from the Ölfusá, Nesland, Litlu Borgarkatlar and Thorodstadaengjar, but the plants from all these localities

are only forms of *H. giganteum*, which often occurs in slender, slightly branched forms, which are very difficult to distinguish from *H. cordifolium*. As a rule, however, the old typical shoots from the previous year may be found at the bottom of the tuft, from whence the *cordifolium*-like shoots proceed. Near Grunnavik *H. cordifolium* grew abundantly on boggy, partly inundated ground, and there it was richly fruiting. On the damp ground it was flaccid and prostrate, in water erect in large, deep cushions.

312. **Hypnum Richardsonii** (Mitt.) Lesq. et James.

Amblystegium Richardsonii Lindb.

E. Iceland: Skorastadr (H. J.)! fr.; Seydisfjördur!, abundantly at an altitude of 350 metres. N. Iceland: Thorodstadaengjar (St.)!; Ljosavatn! fr., at an altitude of about 250 metres; Husavik!. NW. Iceland: Ármuli!. W. Iceland: Mödruvellir!, at an altitude of about 200 metres; Hjallaháls (H.J.)!. S. Iceland: Barkastadr!, at an altitude of 530 metres.

This species is probably more frequent than may be believed, judging from the few habitats, but it is often overlooked on account of its resemblance to the exceedingly common *H. cuspidatum* and *H. giganteum*. It grows in bogs, often abundantly, associated with *H. stramineum*, *H. sarmentosum*, *H. revolvens*, *H. exannulatum*, etc., and often sets fruit which ripens in the middle of July.

313. **Hypnum giganteum** Schimp.

Amblystegium giganteum De Not.

Very common.

Grows in bogs, where it is often the most abundant constituent of the vegetation, especially in the wettest situations, in channels and pools. Near Akureyri it was common in bogs even at an elevation of 600—700 metres. Fruit, which occurs rather frequently, ripens in the first half of July.

314. **Hypnum stramineum** Dicks.

Amblystegium stramineum De Not.

Very common over the whole of Iceland.

It grows on damp ground, usually intermixed in tufts of other *Hypnum* spp., *Sphagna*, *Cinclidium*, *Mnium*, etc. On very wet ground it often forms pure extensive growths. Thus, near Ljosavatn, it grew in the wettest parts of a bog at an altitude of 400 metres, in extensive, richly fruiting mats, 10—20 cm. deep. In depressions in the rocky flat it forms in association with *H. sarmentosum*, *H. revolvens* and *H. exannulatum* low, dense almost black growths.

Fruit was ripe near Ljosavatn on July 18th.

315. **Hypnum sarmentosum** Wahlb.

Amblystegium sarmentosum De Not.

Commonly distributed on boggy ground, but as a rule not plentifully, mixed with other *Hypnaceæ* or in unmixed tufts.

It varies considerably in size and colour. The slender High Alpine forms, which occasionally form the bulk of the vegetation at an altitude of 500—700 metres, sometimes approach so close to *H. stramineum* that it may be difficult to keep these two species distinct from each other.

In S. Iceland it has been found in many places from about 300 metres upwards, but it has not been found in the low land. In the other parts of Iceland it is distributed from the low land up to about 700 metres above sea-level, but appears to be most frequent above a height of about 200—300 metres. It has been collected in fruit near Hof in E. Iceland, Ljosavatn in N. Iceland where it occurred abundantly in bogs at an altitude of about 250—300 metres, and near Grunnavik in NW. Iceland where it was the most abundant constituent of the vegetation in a bog. The fruit, in the specimens from all these localities, was green in the middle of July.

316. **Hypnum trifarium** W. et M.

Amblystegium trifarium De Not.

E. Iceland: Seydisfjördur!; N. Iceland: Vatnsskard!.

In both the above localities it was growing rather scantily on very wet boggy ground, in company with *Hypnum scorpioides*, *H. stramineum* and *H. revolvens*.

317. **Hypnum turgescens** Th. Jensen.

Amblystegium turgescens Lindb.

E. Iceland: Djupivogur!. N. Iceland: Svinadalur!. S. Iceland: Barkarstadr!, at an altitude of 530 metres.

It grew everywhere abundantly on boggy ground, in company with *Hypnum revolvens*, *H. scorpioides* and *H. polygamum*.

318. **Acrocladium cuspidatum** (L.) Lindb.

Hypnum cuspidatum L.

Very common.

This species grows on more or less damp ground, especially in bogs and damp meadows, but also in the water itself in moss bogs and pools, or on damp rocks. As a rule it does not ascend higher than 250—300 metres above sea-level. In S. Iceland it has been found, however, in several places up to a height of about 500 metres.

Fruit, which occurs rather frequently, was ripe about July 1st.

319. **Scorpidium scorpioides** (L.) Limpr.

Amblystegium scorpioides Lindb.

Very common.

It usually grows in the wettest parts of the bogs, often in the water itself, in association with *Hypnum giganteum* and *H. exannulatum*. In the greater part of the country it is met with everywhere in such localities; only in SW. Iceland (Fljótshlid and Eyjafjall does it appear to be less frequent. It appears only by exception to ascend higher than about 300 metres, near Seydisfjördur it was collected at an altitude of 400 metres. Only sterile specimens have been found.

320. **Hylocomium proliferum** (L.) Lindb.

Hylocomium splendens (Hedw.) Br. eur.

Very common.

This species is found especially on a dry substratum, for instance on slopes, amongst grass, in heath-soil or as the most abundant constituent of the moss-covering on stones and in coppices. It occurs however also on damper ground, intermixed in tufts of *Sphagnum*, *Sphærocephalus palustris*, *Rhacomitrium hypnoides*, etc., in bogs. *Hylocomium proliferum* is of almost equal frequency at all altitudes. Near Akureyri it was collected at an altitude of 990 metres. Only sterile specimens have been found.

321. **Hylocomium pyrenaicum** (Spruce) Lindb.

Hylocomium Oakesii (Sull.) Schimp.

S. Iceland: Krisuvik (Stp.)!

322. **Hylocomium parietinum** (L.) Lindb.

Hylocomium Schreberi (Willd.) De Not.

E. Iceland: Berufjördur!; Hornafjördur!. S. Iceland: Common everywhere!. Vestmannaey!. W. Iceland: Esja (Grl.;!); Stykkisholmur!; Borgarfjördur!. NW. Iceland: Common!.

Widely distributed in SE., S. and W. Iceland and on the peninsulas of NW. Iceland. In E. Iceland it has not been found north of Berufjördur, and it appears to be absent from the whole of N. Iceland. It usually grows on rather dry ground, for instance in birch coppices, where it almost everywhere forms an essential part of the vegetation, and on moss-grown slopes and in the *Rhacomitrium*-heath, but it occurs also on damper ground, especially on knolls in bogs. It rarely ascends higher than the birch. In NW. Iceland it was collected up to about 300 metres above sea-level, and in Esja it grew among *Rhacomitrium*

hypnoides at an altitude of about 450 metres. Only sterile specimens have been found.

323. **Hylocomium loreum** (L.) Br. eur.

W. Iceland: Esja (Grl.;!), common up to about 400 metres above sea-level; common in the coppices of the district of Borgarfjördur!; Berserkjarhraun; Arnarbotn; Budahraun (H. J.)!; Stykkisholmur!; Brynjudalur (Grl.,!; Hafnarfjördur Grl.;!); Svinahraun!; Kolvidarhol!, up to about 350 metres. NW. Iceland: Sugandafjördur!, up to about 250 metres; Dýrafjördur!, up to about 200 metres. S. Iceland: Widely distributed!; Thingvellir!; Laugardalur!.

Widely distributed in the whole of the southern and south-western part of Iceland as far as Borgarfjördur and Snæfellsnes. It also occurs rather plentifully in some of the fjords of the north-west. It grows sometimes in clefts among fallen blocks of rock, sometimes on slopes together with other *Hylocomium* spp., *Dicranum scoparium*, *Rhacomitrium* spp., etc., or in the birch coppices. It was collected in fruit near Holt in S. Iceland, where a few old, empty capsules were found.

324. **Hylocomium triquetrum** (L.) Br. eur.

Iceland (Koenig). E. Iceland: Frequent from Berufjördur southwards!. N. Iceland: Asbýrgi!; near Eyjafjördur (O. D.;!); Ljosavatn Grl.;!); common west of Blóndudalur!. NW. Iceland: Rather common in all the fjords!. W. Iceland: Rather common everywhere (Grl.;!. Vestmannaey!. S. Iceland: Common!.

Commonly distributed from Berufjördur in E. Iceland throughout the whole of S., SW. and W. Iceland, and in the majority of the fjords of the north-west. It is rather rare in North Iceland proper, east of Blóndudalur, and occurs, as a rule, only scantily in the coppices or in the *Betula nana* heath.

Its growth is similar to the other species of *Hylocomium*, with which it is almost always found associated, especially in coppices and on moss-grown slopes. It has the same altitudinal distribution as *H. loreum* and *H. parietinum*, as it hardly ascends higher than to the upper limit of the birch. In Esja it is common up to 350–400 metres, near Kolvidarhol it was found in company with *H. loreum* at 350 metres, and in NW. Iceland it everywhere accompanies the birch to its upper limit at about 250 metres. Only sterile specimens have been found.

325. **Hylocomium squarrosum** (L.) Br. eur.

Very common over the whole of Iceland.

It grows both on a damp substratum, on stony flats as on boggy ground, and on a more dry substratum, associated with other *Hylocomium* spp., *Hypnum uncinatum*, etc. It is most frequent in the low land, but occurs, however, also at rather considerable altitudes. In Berufjardarskard it was found even at 500—600 metres, near Dýrafjördur at 330 metres and in S. Iceland in many places up to about

500–550 metres above sea-level. Only sterile specimens have been found.

325. **Hylocomium rugosum** (Ehrh.) De Not.

Widely distributed on dry grass or moss-grown slopes or flats, usually mixed with other Bryophyta such as *Hylocomium parietinum*, *H. proliferum*, *H. squarrosum*, *Rhacomitrium hypnoides*, *Dicranum scoparium*, *Ptilidium ciliare*, etc., rarely unmixed in large mats. It has the same altitudinal distribution as *H. triquetrum*, and hardly ascends higher than about 300–400 metres above sea-level. Only sterile specimens have been found.

II. THE BRYOPHYTE COMMUNITIES.

As in the other Arctic and Sub-arctic countries, the Bryophyta play a very important part in the plant-covering of Iceland. They occur either as an essential component of, so to speak, all plant associations, and often in far greater numbers as regards species and individuals, than do the higher plants, or as distinct Bryophyte associations from which other plants are entirely absent, or in which they occur only as a subordinate component.

As a basis of classification it comes natural to distinguish between (1) Lowland Formations and (2) Highland Formations. Within these two main groups the formations are again arranged according to their water-requirements, commencing with those which are the most water-loving. Naturally, no sharp limit can be drawn between these formations; on the contrary, all possible transitions between them are constantly met with, which makes a comprehensive survey extremely difficult. In addition to this, the investigations are in many respects very incomplete, especially with regard to the history of development of the Bryophyte associations. Also, several of the formations occur both in the Highlands and in the Lowlands. This is especially the case with decidedly xerophilous formations like the *Rhacomitrium* heath and, partly, also other moss-heaths.

Mountain plateaus and slopes situated above the growth-limit of the birch and the heather moor are in this paper considered as belonging to the Highlands (the Alpine Region). The limit in question may lie at various levels and can, of course, never be drawn sharply, but is in many cases dependent on the structure of the mountains. The flat land along the coasts and at the bottom of the valleys rises, as a rule, in terraces inwards towards the high

land. As far upwards as about 200—400 metres the slopes and flats are covered with heaths and birch-coppices or bogs respectively. Then usually follow steep, bare slopes of gravel or abrupt cliffs, and the plateaus which follow these bear the scanty plant-covering of the rocky flat.

The conditions, however, differ somewhat in different parts of the country. In NW. Iceland there is almost no low land with the exception of the narrow stretch of coast along the narrow, deep fjords. The steep, often vertical cliff-faces rise to a height of 500—600 metres and have a talus of débris (Urd) at their foot, and cliffs rising in terraces occur almost exclusively at the head of some of the fjords. The entire surface at the top of the mountain belongs to the rocky flat, and the associations characteristic of the latter often occur on the slopes and flats right down to the level of the sea, especially on slopes facing north.

In S. Iceland, on the other hand, in sheltered valleys, localities are met with as far upwards as 500—600 metres above sea-level, which, according to the composition of the plant-covering, must be referred to the Lowland formations.

I. THE LOWLAND FORMATIONS.

The Littoral Bryophyte Vegetation.

There are only very few species which are restricted to the immediate vicinity of the sea, or which grow by preference in the neighbourhood of the coast. *Schistidium maritimum* and *Ulota phyllantha* doubtless occur wherever there are rocky coasts, and are rarely found many hundred metres from the coast. They chiefly occur along the sea-coast itself, and at the entrance to the larger fjords, and decrease in frequency inwards towards the head of the fjord. Near Berufjördur, for instance, both species are very common around Djupivogur, but are entirely absent from the inner part of the fjord, and this is also the case in Seydisfjördur. Around the broad Isafjördur they are common as far inwards as Arngerdareyri, but are, as a rule, absent from the narrow branch-fjords. Both species grow on the coast rocks, but also frequently descend to the ground. On the island of Vestmannaey *Ulota* was very common on knolls in fields, where the grass-covering had been torn up by the wind, and *Schistidium maritimum* has been found in several places on damp sandy soil.

Orthotrichum Blyttii occurs here and there on coast rocks, or at any rate in the immediate neighbourhood of the coast. *Pottia Heimii* is commonly distributed along all flat coasts and *Amblystegium littorale* occurs here and there on damp sandy soil.

Besides these littoral species proper, there are several others which occur especially abundantly on the coast, but are also distributed in many other localities. *Bryum argenteum* and *B. capillare* grow especially below cliffs inhabited by sea-fowl, but their presence there is, no doubt, as much due to the abundant supply of organic manure at to the proximity of the sea. *Desmatodon latifolius*, *Leptobryum pyriforme* and *Tortula ruralis* are also typical of damp sandy soil and *Hypnum polygamum* of saline, boggy soil. On damp sandy soil on the beach low, scattered moss-cushions consisting of stunted individuals of many different and more casual species are often met with, for instance, *Distichium montanum*, *Didymodon rubellus*, *Ceratodon purpureus*, *Encalypta rhabdocarpa*, *Myurella julacea*, *Bryum* spp., etc.

Hydrophilous Bryophyte Formations.

The water originating from rain and mist or from melting snow will, according to the local conditions and the inclination, either spread out over the ground and — if it consists of humus or sand — sink into it, or seek outlets in brooks and rivers. Where the water remains standing without being able to find a sufficient outlet, a bog vegetation is developed, or, in deeper hollows, a lake is formed. Part of the water which sinks down to the solid rocky substratum continues its way downwards along the latter until it sooner or later issues as a spring. Stagnant water contains humus substances, is not well aerated, and is warmed by the sun, while running water, both in streams and springs, is pure and clear and contains oxygen and carbonic acid. Running water has a very low temperature during the summer, at the most 4°—6°. Therefore the composition of the vegetation on boggy ground differs entirely from that on ground along streams and near springs, inundated or saturated by the pure water.

The hydrophilous formations may be classified as follows: —

A. The Bryophyte Vegetation of Pure Water.
- a. The Bryophyte Vegetation of Running Water and of Lakes.
- b. The Bryophyte Vegetation of Inundated Gravelly Soil (slightly inclined ground and banks of streams).
- c. The Bryophyte Vegetation on Muddy Soil near Springs (Dý).

B. The Bryophyte Vegetation of Boggy Soil[1].

C. The Bryophyte Vegetation of Damp Sandy Soil.

D. The Bryophyte Vegetation near Hot Springs.

The Bryophyte Vegetation of Running Water and of Lakes.

The Bryophyte Vegetation of Lakes is extremely scanty, and often entirely absent. Along the shores of shallow lakes the surrounding swamp-vegetation may extend right into the water, especially species such as *Hypnum giganteum*, *H. exannulatum* and *H. scorpioides*, while rocky shores are usually quite bare of submerged Bryophyte vegetation or bear, here and there, one or other of the species growing in streams, such as *Fontinalis antipyretica* or a *Hypnum*-species. How far Bryophyta (for instance, *Fontinalis*) may occur in deeper water has not been investigated.

Glacier-rivers, on account of their torrential current and changeable course, as well as of the low temperature of their clay-containing water, are entirely devoid both of Bryophyte vegetation and of higher plants.

Brooks and Rivers. Where the bottom consists of loose gravel and smaller stones which are kept by the water in constant motion, Bryophyte vegetation is entirely absent. But if the bottom is of firm rock or larger stones it is, as a rule, covered with extensive moss-carpets which usually consist of *Hypnum ochraceum* or *Fontinalis antipyretica*, which may, either separately or together, cover large areas of the bottom. In very strong currents *H. ochraceum* forms the highly elongated and often thread-like var. *filiforme* which, together with *Rhynchostegium rusciforme* var. *atlanticum*, is a characteristic species of torrential rivers on much inclined ground. *H. ochraceum* var. *filiforme* is found especially in larger streams, where it is then the only species occurring, while *Rhynchostegium*

[1] In this paper no distinction has been made between swampy soil, marshy soil and boggy soil, the term "boggy" includes all three kinds of soil. The Danish term in all three cases is "sumpet".

appears to prefer smaller rivers with large loose blocks of rock at the bottom.

Several other Bryophyta occur either mixed with the above or occasionally as dominants in the Bryophyte vegetation. *Schistidium rivulare* is very common and often occurs abundantly. *Hypnum dilatatum*, *H. alpinum* and *H. alpestre* are common in the northern and eastern parts of the country, but are absent from or are rare in other parts. In the river Ellidará near Reykjavik the bottom was in several places covered with *Fontinalis androgyna*. In shallower water, and especially on inundated rock-surfaces in waterfalls, several other species also occur. Almost everywhere in such localities are found: *Haplozia cordifolia*, *Scapania undulata*, *Brachythecium rivulare*, *Rhynchostegium rusciforme*, *Hypnum palustre*, *H. falcatum*, *Philonotis fontana*, *Mniobryum albicans* var. *glacialis*, *Bryum Duvalii* and *Bryum ventricosum* together with some of the species which thrive best in places where they are outside the water during a part of the year.

Stones and rocks which protrude above the surface of the water and are inundated only during specially high water-levels are usually covered with a dense moss-carpet consisting of numerous species. In addition to the majority of the species of river-bottoms there occurs also an abundance of those belonging to damp rocks. Among the species which are rarely absent from such localities may be mentioned: *Hypnum falcatum*, *H. filicinum*, *Schistidium rivulare*, *S. gracile*, *Rhacomitrium aciculare*, *R. sudeticum*, *Blindia acuta*, *Dichodontium pellucidum*, *Amphidium Mougeottii*, *Haplozia atrovirens* and *Mnium punctatum*, and in North and East Iceland, in addition to the above-mentioned, *Philonotis seriata* and *Hypnum decipiens* are to be found. A somewhat different vegetation occurred in the river Rekyirdalsá in SW. Iceland, which is so well supplied from hot springs that in the beginning of June the water had a temperature of about 12°, while that of the streams flowing into it on both sides was only 4°—5°. *Hypnum ochraceum*, which is elsewhere so common, was entirely absent, and *Schistidium rivulare* occurred very scantily. On rock-surfaces and larger stones *Hypnum palustre*, *Brachythecium rivulare* and *Rhynchostegium rusciforme* grew abundantly, the last had also set fruit. *Fontinalis longifolia* covered the bottom in many places, and on stones protruding above the surface of the water *Hypnum filicinum* and *Schistidium gracile* were growing. In the cold tributary streams the usual vegetation occur-

red, consisting of *Hypnum ochraceum*, *H. falcatum*, *Schistidium rivulare*, *Rhynchostegium rusciforme* var. *atlanticum* and *Scapania undulata*.

The Bryophyte Vegetation of Inundated Gravelly Soil (slightly inclined ground and banks of streams).

Where the water flows down the mountain sides and spreads over slightly inclined gravelly ground, and along the flat banks of streams which are periodically inundated, a vegetation composed mainly of Bryophyta is developed. The most conspicuous species growing on this gravelly ground, and one which is hardly ever absent, and is often the most abundant constituent of the moss carpet, is *Philonotis fontana*, and after it this community may be designated the Philonotis association (Ostf., 1907). Very frequently many other species also occur, either as an admixture in the *Philonotis* carpet, or replacing it over smaller or larger areas. In NW. Iceland *P. fontana* is often replaced by *P. seriata*. *Mniobryum albicans* var. *glacialis* is almost as common as *Philonotis*; and *Bryum ventricosum*, *B. Duvalii*, *Brachythecium rivulare* and *Acrocladium cuspidatum* are also among those species which are rarely absent.

As a few examples will best show the composition of this vegetation, the following are given: —

1. The Ellidará near Reykjavik: The mossy fringe along the banks consisted of *Philonotis fontana*, *Dichodontium pellucidum* and *Acrocladium cuspidatum*.

2. Husavik, along a stream: A broad belt of *Cinclidium stygium* together with some *Paludella squarrosa*.

3. Husavik, along the banks of smaller streams on a slope: *Mniobryum albicans* var. *glacialis*, *Mnium punctatum*, *Philonotis fontana*, *Marchantia polymorpha* together with some *Bryum Duvalii* and *Thuidium lanatum*.

4. Berufjördur, along a stream: *Philonotis fontana*, *Mnium Seligeri*, *Hypnum giganteum* and *Mniobryum albicans* var. *glacialis*.

5. Svinaskard, along a small stream: *Philonotis seriata*, *Scapania undutata*, *Chiloscyphus polyanthus* and *Pellia Neesiana*.

6. Kaldalon (NW. Iceland), in a small stream and on gravelly ground over which water was flowing: *Philonotis seriata*, *P. fontana*, *Dicranella squarrosa*, *Mniobryum albicans* var.

glacialis, *Bryum Duvalii*, *Chiloscyphus polyanthus* var. *fragilis*, *Harpanthus Flotowianus* and *Pellia Neesiana*.

7. Kaldalon, along the banks of a stream: *Hypnum callichroum*, *Sphagnum teres*, *Harpanthus Flotowianus* and *Cephalozia bicuspidata* var. *Lammersiana*.

8. Reykjavik, on ground over which water was flowing: slightly inclined surface with streamlets. The banks of the streamlets were fringed with *Philonotis fontana*, *Mnibryum albicans* var. *glacialis*, *Bryum ventricosum*, *B. Duvalii* and *Acrocladium cuspidatum*.

9. Gnupsdalur (NW. Iceland), gravelly ground, over which water was flowing, streamlets flowing down the sides of the valley: *Philonotis seriata*, *P. fontana*, *Dicranella squarrosa*, *Haplozia cordifolia*, *Chiloscyphus polyanthus* var. *fragilis*, *Scapania undulata* and *S. paludosa*. *Haplozia* formed large black or greenish-black, and *Scapania paludosa* very large reddish-brown patches in the water, which was a few centimetres deep.

In North Iceland several species of *Hypnum* occurred abundantly in gravelly soil over which water was flowing, and often formed pure Hypneta. Especially do *Hypnum exannulatum* var. *purpurascens*, *H. falcatum*, *H. decipiens* and sometimes *H. stramineum* and *H. sarmentosum* occur in such localities.

The Bryophyte Vegetation on Muddy Soil near Springs (Dý).

The bright-green moss-carpet around and below the point of issue of the springs described by Helgi Jónsson (1900, p. 24; 1895, p. 73) as moss bogs (Icelandic Dý) are one of the most frequently occurring and characteristic plant communities of the Arctic and Sub-arctic regions. They were first mentioned by Grönlund (1877, p. 330) as mats of sapgreen mosses along small streams on mountain sides, consisting of *Bartramia fontana*, *Webera albicans*, *Brachythecium rutabulum* var. *rivulare* and *Hypnum uncinatum*, a description which includes both the moss bogs and the moss vegetation along smaller streams, which have also much in common.

Moss bogs develop in muddy soil, in all places where the ground water emerges as springs. They occur both on mountain slopes and at the bottom of valleys, occasionally also at higher levels, on rocky flats, but they are especially numerous on the lowest mountain slopes and in the flat boggy land below these

slopes. There they lie irregularly scattered in bright-green patches, differing greatly in size, and conspicuous even at a distance by their colour which is distinct from that of their surroundings. Higher up on the slopes at the foot of the bluffs, they frequently form continuous belts in connection with the mossy fringe along the downward-flowing streams (Helgi Jónsson, 1900, p. 25).

The vegetation consists of nearly the same species as those found on inundated gravelly soil, and the external conditions for the plants are also essentially the same in both places, since it is the cold, well-aerated water which determines the composition of the vegetation. During summer the temperature of the water is usually only 4°–5°, and this low temperature acts as a great check to the growth of higher plants, and is therefore indirectly favourable to the moss vegetation. The difference between the two vegetations is especially due to the substratum, that of the vegetation of inundated ground and stream-banks consisting of gravel, while the moss bog developes on mud. For this reason also, some of the species which occur in the gravelly soil are absent from the moss-bogs proper, for instance *Hypnum falcatum*, *H. decipiens*, *Dicranella squarrosa*, *Philonotis seriata*, *Haplozia cordifolia*, *Scapania paludosa* and *Chiloscyphus polyanthus* var. *fragilis*.

On flat ground moss bogs are, as a rule, almost circular in shape, and the species are arranged concentrically around the point of issue of the spring, whence the water gradually oozes through the moss carpet, and spreads out over the surrounding boggy ground. On sloping ground the moss bog is usually oblong in shape, and the spring emerges at its upper end (Fig. 19).

In the majority of cases the Bryophyte vegetation near springs (the Dý) is a *Philonotis-Mniobryum* association, in which other species of Bryophyta and a few higher plants occur scattered (Ostf., 1907, p. 69). On the soft mud around the point of issue of the spring — and often covering the latter — *Mniobryum albicans* var. *glacialis* usually grows, and outside the latter there is a broad belt of *Philonotis fontana*, which may be intermixed with or replaced by other mosses; and scattered in the moss carpet are a few flowering plants and vascular cryptogams, especially *Montia rivularis*, *Saxifraga stellaris*, *Epilobium* spp. and *Equisetum palustre*.



Fig. 19. Kaldalon (NW. Iceland). Slightly inclined ground below the stony slope. The light-coloured stripes are moss bogs, the darker, boggy ground or, on somewhat higher levels, patches covered with *Vaccinium-Empetrum* heath.

Besides the above-mentioned mosses the following plants are characteristic of the moss bog: —

Brachythecium rivulare
Acrocladium cuspidatum
Hypnum Kneiffii
Bryum ventricosum
B. Duvalii
Mnium punctatum
M. Seligeri
M. cinclidioides
M. affine var. elatum
Marchantia polymorpha
Pellia Neesiana

But also other Bryophyta from bogs may occur intermixed with these, especially towards the edge, where the moss bog gradually passes into the common bog-vegetation. But of course all possible transitions also occur, between moss bog and bog vegetation as well as between moss bog and the vegetation of the banks of streams, all according to the nature of the underlying substratum.

As some examples will best show the composition of the moss bogs, the following are given: —

1. Seydisfjördur, numerous moss bogs on an almost hori-

zontal, boggy surface, below the slope of the mountain (Fig. 20). The vegetation was almost identical in all of them: In the middle, *Mniobryum albicans* var. *glacialis* was found intermixed with *Montia rivularis*, then came a belt of *Philonotis fontana*, often greatly intermixed with *Marchantia polymorpha* and with scattered plants of *Saxifraga stellaris, Equisetum palustre* and *Epilobium* spp. In some moss bogs a pure Hypnetum composed of *H. exannulatum* var. *purpurascens* or *H. Kneiffii* had been developed.



Fig. 20. Moss bog near Seydisfjördur. The light-coloured patch in the middle is *Mniobryum albicans* var. *glacialis*. In the foreground and on the sides *Philonotis fontana*.

2. Husavik, moss bog on slightly inclined ground: In the middle *Mniobryum albicans* var. *glacialis* and *Marchantia polymorpha* were found, and around this a belt of *Bryum ventricosum* f. *major*, *Mnium affine* var. *elatum* and *Philonotis fontana*, and outside it all an almost pure belt of *Philonotis*.

3. Breidabolstadr, slightly inclined grassland with scattered moss bogs: In the middle *Mniobryum albicans* var. *glacialis* grew intermixed with *Bryum ventricosum* f. *major*; around this was a belt of *Philonotis fontana*, and outside it all *Mnium affine* var. *elatum* and *Acrocladium cuspidatum*. Some smaller moss bogs below the slope

were composed of *Brachythecium rivulare, Mniobryum albicans* var. *glacialis, Philonotis fontana, Bryum ventricosum, Mnium Seligeri* and *Mnium affine* var. *elatum,* which grew in patches intermixed.

4. Holt (S. Iceland), moss bog below a slope: *Acrocladium cuspidatum, Mniobryum albicans* var. *glacialis, Bryum ventricosum* f. *major, Mnium punctatum, M. Seligeri* and *Pellia Neesiana* grew intermixed, sometimes as single plants and sometimes in patches. In the middle *Montia rivularis* grew among the mosses.

The majority of the mosses growing near springs form special cold-water forms which are particularly characterized by their highly elongated, slightly branched stems of almost equal height, by which feature they all assume a homogeneous habit. *Brachythecium rivulare* forms a form with long, erects shoots of equal height and with appressed leaves. *Philonotis fontana* forms, when growing in very cold water, a highly elongated, hardly tomentose form with appressed, shortly pointed leaves with short leaf-cells and very broad nerve (forma *adpressa*). The cold-water form of *Bryum ventricosum* (f. *major*) is also higher in growth and more vigorous than is the bog-form, has stems bare of tomentum with large and broad, spreading leaves. *Mniobryum albicans* var. *glacialis* is also much more vigorous than the type, with larger and broader leaves. *Mnium* spp. develop *elatum*-forms with erect, sterile shoots of equal height.

The Bryophyte Vegetation of Boggy Soil.

The bog vegetation is extensively distributed about Iceland, especially in the low land, and in many places it occupies almost the whole tract of land between the mountain slopes and the sea. The lower mountain plateaus and slightly inclined slopes up to a height of about 300—400 metres are also to a great extent covered with bogs (Sedge-bogs). The mode of formation of these bogs has been described by Helgi Jónsson (1895, p. 45). They originate partly from the further development of the vegetation of the springs and the banks of streams, and partly from shallow lakes first forming in depressions and afterwards becoming gradually filled up with plants in connection with sand transported by the wind. In the former case a drier bog (mýri, pl. mýrar) is formed, the sedges superseding the mosses; in the latter case a wet bog (flói, pl. flóar) is first formed, which, by gradually becoming overgrown with plants, develops into a "myri"[1].

[1] For a description of "myri" and "flói" see also Thoroddsen's Physical Geography of Iceland, ante p. 323.

In "Die Moose des Sarekgebietes" (1910, p. 248) C. Jensen classifies the bog vegetation in four formations: The Willow bog, the Sedge bog, the Moss bog and the Peat bog. This classification cannot be entirely adopted as regards Iceland. Willow bogs proper (willow coppices in boggy soil) do not appear to be developed there. True, scattered individuals or small groups of *Salix* (*S. lanata*, *S. phylicifolia* and *S. glauca*) are often found in the sedge bogs, especially in NW. Iceland, but the moss vegetation there does not differ in any respect from that of the surrounding sedge bog.

The vegetation of boggy soil is composed mainly of mosses and sedges, greatly varying in abundance. Sometimes the sedges are the dominant plants, and then the moss carpet is less conspicuous at the bottom, among the *Carex* and *Eriophorum* spp.; sometimes there is a continuous moss-carpet in which the higher plants grow scattered, and then the one formation may be termed a sedge bog, and the other a moss bog, which, however, does not correspond with Helgi Jónsson's definition of a moss bog, but appears to agree with Warming's description (1887, p. 132). They are the same mosses which occur in the same manner in both formations, and all possible transitions are found between these.

Helgi Jónsson (1900, p. 20; 1905, p. 9) classifies the bog vegetation into Star-grass bogs and Moss bogs. The latter, which include the vegetation along streams, on inundated ground and near springs (Dý), and also some of the moss bogs in Warmings definition, have been treated in the preceding section. The star-grass bogs are again divided into "Mýrar" and "Flóar". In the Mýri the ground water stands on a level with the surface, the soil contains acid humus and is so closely interwoven with rhizomes and roots that it bears one like a carpet. In the Flói the ground water stands above the surface, the soil is muddy and produces a more scattered vegetation of *Carex* and *Eriophorum* tufts. As it is chiefly the height of the ground water which determines whether a Mýri or a Flói is developed, and the Flói is formed by the filling up of a shallow lake, there occur all transitions between lake and Flói, and through further development, between Flói and Mýri.

The Flói is poor in mosses. The soft muddy soil is not favourable to their growth, and it is only as an exception that some of the species are found which grow along the banks of lakes, but often the moss-covering is entirely absent. *Hypnum scorpioides* and *H. giganteum* are the most frequent species which

occur everywhere in pools and channels. *Hypnum exannulatum*, *H. revolvens* var. *Cossoni* and *Acrocladium cuspidatum* are also frequent. In many places in East Iceland *Cinclidium stygium* was found abundantly in Flóar, while *Hypnum cordifolium* and *H. fluitans* were found in a few places only.

The moss-covering of the Mýri is characterized by the fact of its being rich in species, which grow sometimes greatly intermixed, sometimes separately in large and small patches. The ground is usually knolly, and there is a great difference in the vegetation between and upon the knolls, the most hygrophilous species growing on the wet ground between the knolls, while on the top of the knolls mesophilous and xerophilous forms are met with, and between these all transitions occur, according to the height of the knoll and the degree of moisture. They are nearly the same species which are everywhere the most abundant constituents of the Mýri vegetation. The following species occur on the ground between the knolls: —

Musci veri

*Hypnum revolvens
* — intermedium
* — stramineum
* — stellatum
* — polygamum
* — sarmentosum
* — Lindbergii
* — exannulatum
* — giganteum
— Richardsonii
— falcatum
— trifarium
— turgescens
*Camptothecium nitens
*Brachythecium rivulare
*NE.) Thuidium lanatum
*Acrocladium cuspidatum
*Philonotis fontana
*Meesea trichoides
Meesea triquetra
*Paludella squarrosa
*Catoscopium nigritum
*Cinclidium stygium
*Mnium cinclidioides
* — punctatum
* — affine
* — Seligeri
* — subglobosum
*Bryum ventricosum
*Splachnum vasculosum
* — sphæricum
(*NE.) Dissodon splachnoides
*Oncophorus Wahlenbergii
* — virens
Dicranum angustum
*Fissidens osmundoides
*Dichodontium pellucidum
Campylopus Schimperi

Sphagna

*Sphagnum teres
* — rubellum
* — Warnstorffii
* — fimbriatum
* — medium
* — Girgensohnii
* — subnitens
Sphagnum papillosum
— inundatum
— squarrosum
— acutifolium
— riparium
— Lindbergii

Hepaticæ

*Pellia Neesiana	*Lophozia quinquedentata
*Aneura pinguis	— quadriloba
* — multifida	— Schultzii
*Cephalozia bicuspidata	— Hornschuchiana
* — pleniceps	*Scapania irrigua
*Cephaloziella Hampeana	— uliginosa
* — rubella	— undulata
Odontoschisma elongatus	*Blepharostoma trichophyllum
*Alicularia scalaris	*Anthelia julacea
*Lophozia Kunzeana	

In the above list an asterisk is prefixed to those species which are common over the whole of Iceland, and which are met with in almost every considerable boggy tract. Some of the species are common in some districts and absent from others, for instance *Thuidium lanatum* and *Dissodon splachnoides*, which are very common in North and East Iceland, but are rare or entirely absent from other parts of the country, and *Campylopus Schimperi*, which is found only in the southern part.

The mosses often grow so much intermixed that a small collection may contain 15—20 or even more species, but often smaller and larger patches are found dominated by a single species. Thus *Catoscopium*, *Philonotis*, *Cinclidium* or *Mnium* bogs occur, in each of which one of these species is the dominant member. On very damp ground the mass of the vegetation is formed by, for instance, *Mnium cinclidioides* or *Cinclidium stygium*, and in South Iceland by *Mnium Seligeri*. In North and East Iceland it is especially *Thuidium lanatum* which is often the most conspicuous species.

Sphagnum spp. grow almost always in scattered tufts, and *Sphagnum* bogs proper are rarely met with. Helgi Jónsson (1900, p. 25) records such bogs from Snæfellsnes, where they occurred on sloping ground and were composed of *Sphagnum teres*, *S. Warnstorffii* and *S. Girgensohnii* intermixed with *Paludella squarrosa*, *Hypnum stramineum*, *Hylocomium squarrosum* and *Polytrichum commune*. I have only seen a similar vegetation near Barkarstadr in South Iceland, where, on a wet boggy slope stretching down towards a river, there was an almost continuous growth of *Sphagnum rubellum* and *S. Warnstorffii* intermixed with a few other mosses, especially *Thuidium lanatum*, *Hylocomium squarrosum* and *Hypnum stramineum*.

Sphagnum spp. often play an important part in the knoll-formation of the mýri, the large *Sphagnum*-cushions being inter-

woven with mosses and hepatics, and different plants such as *Vaccinium* spp., *Betula nana, Comarum palustre* and several *Carices* then establishing themselves upon these cushions.

The numerous hepatics which occur are everywhere found interspersed in the moss carpet, especially in that upon the knolls, and, as regards all the species mentioned below, doubtless also in the ground vegetation between the knolls.

The Bryophyte Vegetation of Knolls[1] is dependent upon the varying degree of moisture, which is greatest on the ground between the knolls and least in their uppermost part. Some of the Bryophyta of the ground do not ascend higher than to the base of the knolls, while others, especially many of the pleurocarpous mosses, occur with equal frequency upon and between the knolls. In addition to the latter mosses the following species are found upon the knolls: —

*Hypnum uncinatum
— imponens
*Climacium dendroides
*Hylocomium squarrosum
* — parietinum
* — proliferum
Orthothecium chryseum (N. Icel.)
*Polytrichum alpinum
* — strictum
* — juniperinum
*Aulacomnium palustre
*Mnium hornum
*Rhacomitrium canescens
* — hypnoides
*Ditrichum flexicaule
*Dicranum scoparium
* — congestum
* — elongatum
*Lophozia lycopodioides
*Plagiochila asplenioides
*Ptilidium ciliare,

and besides these, numerous other species which belong to other formations and must rather be regarded as casual visitors.

The following examples will show the composition of the bog vegetation in the different parts of Iceland: —

1. Skálholt in SW. Iceland. The country here over a wide expanse is covered with vast boggy areas in which small, protrud-

[1] According to my observations these knolls are formed either by soil accumulating in tufts of *Sphagnum*, etc., in which other plants take root, among others sedges, when soil again accumulates, or by soil accumulating directly around roots of sedge-tussocks. This accumulation of soil and plants continues till big knolls are formed, some 60—70 cm. in height. These knolls occur in all stages of development, from tufts or tussocks with a slight accumulation of soil around their roots to completely rounded knolls in which the tussocks have entirely disappeared. In Danish "Tue" stands both for "knoll" and for "tuft" and "tussock", which is very convenient when referring to one of the various stages of these "knolls". But the rendering into English has been difficult, though in each case the term most appropriate to the stage of development of the "knoll" has been carefully chosen.

ing masses of rock (holt) occur scattered. In the wettest parts of the mýri grew *Hypnum scorpioides*, *H. giganteum* and some *H. revolvens* v. *Cossoni*. The moss-covering of the ground between the knolls consisted mainly of *Hypnum revolvens*, *H. stellatum*, *H. Lindbergii*, *H. stramineum*, *Acrocladium cuspidatum*, *Hypnum polygamum*, *Hylocomium squarrosum*, *Camptothecium nitens*, *Mnium Seligeri*, *M. cinclidioides*, *Philonotis fontana* and *Bryum ventricosum*, all of which grew intermixed. Of more scanty occurrence were *Hypnum sarmentosum*, *Paludella squarrosa*, *Meesea trichoides*, *M. triquetra*, *Cinclidium stygium*, *Mnium punctatum*, *Splachnum vasculosum*, *S. sphæricum*, *Fissidens osmundoides*, *Oncophorus Wahlenbergii*, *Alicularia scalaris* and *Aneura pinguis*. The following hepatics grew both between and upon the knolls: — *Lophozia Kunzeana*, *L. quinquedentata*, *Scapania irrigua*, *Cephalozia pleniceps*, *C. bicuspidata* and *Cephaloziella Hampeana*. The knolls were usually formed by *Sphagna*, especially by *S. teres*, *S. Warnstorffii* and *S. rubellum*, and in very wet parts of the mýri also by *S. medium*. Woven into and above the *Sphagnum*-cushions grew *Hypnum uncinatum*, *Hylocomium squarrosum*, *H. proliferum*, *H. parietinum*, *Climacium dendroides*, *Aulacomnium palustre*, *Dicranum scoparium* var. *turfosum*, *Ptilidium ciliare*, *Plagiochila asplenioides*, and, uppermost, *Rhacomitrium hypnoides* and *R. canescens*.

2. Höskuldstadr in E. Iceland. Knolly sedge-bogs with a rich vegetation of mosses between the knolls, along the river at the bottom of the valley. The moss carpet of the ground between the knolls consisted of *Hypnum revolvens*, *H. giganteum*, *H. stellatum*, *Acrocladium cuspidatum*, *Mnium cinclidioides*, *Cinclidium stygium*, *Mnium affine* var. *elatum*, *Paludella squarrosa*, *Philonotis fontana*, *Meesea trichoides*, *M. triquetra*, *Bryum ventricosum*, *Aulacomnium palustre*, *Catoscopium nigritum*, *Oncophorus Wahlenbergii*, *Dichodontium pellucidum* and *Aneura pinguis*. All the Bryophyta, as a rule, grew intermixed, but some of them frequently formed large, pure growths, especially *Catoscopium nigritum* and in the wettest parts *Mnium cinclidioides* and *Cinclidium stygium*. Upon the knolls, which were sometimes formed by *Carex*, sometimes by *Sphagnum*, grew *Camptothecium nitens*, *Thuidium lanatum*, *Hypnum stramineum*, *H. uncinatum*, *Hylocomium squarrosum*, *Sphagnum teres*, *S. Warnstorffii*, and, uppermost, *Hylocomium parietinum*, *H. proliferum*, *Dicranum scoparium*, *Rhacomitrium hypnoides* and *Scapania curta*. Woven into the moss-covering, especially into that upon the knolls, were found *Lophozia Kunzeana*, *L. quinquedentata*, *Scapania irrigua*, *Blepharostoma tricho-*

phyllum, *Plagiochila asplenioides*, *Cephalozia bicuspidata* and *C. Hampeana.* The two sedge bogs described above may be regarded as types, and by far the greater majority of the sedge bogs have very nearly the same vegetation.

3. Breidabolstadr on Fljótshlid (S. Iceland). A flat, boggy tract of meadow-land beneath the low mountain-slope, intersected by ditches and, lowest of all, by a low dike in order to keep the water-level at a suitable height. The ground was even, without knolls, and covered by a vigorous vegetation of *Carices*, with a moss carpet at the bottom. Occasionally there were also patches where the moss-covering was dominant, and the species of *Carex* occurred in this as scattered individuals. The species were comparatively few in number and were usually dominant in spots. The most frequent species were *Philonotis fontana*, *Mnium Seligeri*, *M. cinclidioides*, *Cinclidium stygium*, *Bryum ventricosum* and *Acrocladium cuspidatum.* Here and there patches occurred with a more mixed vegetation, which, in addition to the plants mentioned above, consisted of *Hypnum revolvens*, *Meesea trichoides*, *Splachnum vasculosum*, *Lophozia quinquedentata*, and perhaps of several other species. Here and there were tufts formed by *Sphagnum rubellum* and *S. teres.*

A vegetation of about the same composition as that described above is very commonly met with in South Iceland, where tracts of meadow-land, by means of draining, irrigation or damming up, are kept at about the same ground-water level during the whole summer. The knolls disappear — or are not formed — and the moss-covering becomes poorer in species.

4. Ljósavatn in North Iceland. A rather large sedge bog on very wet ground, on the slightly inclined slope of the mountain. The moss-carpet was composed of *Cinclidium stygium*, *Mnium cinclidioides*, *M. Seligeri*, *Paludella squarrosa*, *Camptothecium nitens*, *Hypnum* spp., *Philonotis fontana*, *Bryum ventricosum*, *Thuidium lanatum*, *Lophozia Kunzeana* and *L. quinquedentata.* *Sphagnum rubellum*, *S. teres*, *S. Warnstorffii* and *S. Girgensohnii* occurred abundantly in large tufts. In the wettest parts, where the water reached above the surface, grew thick, extensive carpets of *Hypnum exannulatum*, *H. stramineum*, *H. sarmentosum*, *H. giganteum* and *H. Richardsonii*, all in very vigorous development, and in fruit. The *Hypnaceæ* sometimes grew intermixed, but usually they occurred separately, and were only slightly mixed with other Bryophyta and Cyperaceæ. This formation corresponds undoubtedly with C. Jen-

sen's *Amblystegium*-bog (1910, p. 253) and occurs rather commonly in North Iceland, but more rarely in the other parts of the country, probably because in North Iceland the climate is more continental than in the rest of Iceland. These moss bogs are most frequently composed of *Hypnaceæ*, but often *Paludella squarrosa*, *Cinclidium stygium* or *Mnium cinclidioides* forms an essential part of them.

5. Isafjördur. The narrow strip of land, below the steep mountain slope (almost 600 metres in height) along the western side of the fjord, is covered with sedge bogs right to the head of the fjord. The most abundant constituents of the moss carpet between the knolls were *Hypnum revolvens, H. giganteum, H. exannulatum, Paludella squarrosa, Philonotis fontana, Mnium cinclidioides, M. punctatum, Cinclidium stygium* and *Bryum ventricosum*. Here and there in the moss carpet grew *Thuidium lanatum, Catoscopium nigritum, Meesea trichoides, M. triquetra* (scantily) and *Oncophorus Wahlenbergii. Splachnum sphæricum* and *S. vasculosum* grew on cow-dung. The knolls were formed by *Sphagnum teres, S. Warnstorffi, Polytrichum strictum, P. alpinum, Mnium hornum* and *Dicranum scoparium*. The following hepatics occurred woven into the moss-cushions: *Lophozia quinquedentata, L. Kunzeana, L. Hornschuchiana, L. quadriloba, Scapania irrigua, Blepharostoma trichophyllum, Harpanthus Flotowianus, Cephalozia pleniceps, Cephaloziella Hampeana* and *C. rubella*.

6. Seydisfjördur. A boggy flat at an altitude of about 350 metres. The ground was covered with a blackish-brown moss carpet composed of *Hypnum giganteum, H. stramineum, H. sarmentosum, H. revolvens, H. Richardsonii, H. exannulatum* and *H. uncinatum*, occasionally alternating with patches of *Mnium cinclidioides*. Tufts of *Sphagnum teres* and *S. Girgensohnii* occurred frequently, and *Splachnum vasculosum* was common on dung. *Carex* spp. and *Eriophorum* were abundant without, however, occurring so densely as to cover the ground. This type of *Hypnum* bog, from which other plants are most frequently entirely absent, is common in North and East Iceland at elevations of about 200—500 metres, on flats where the snow lies long. The moss carpet is, as a rule, thin and bears distinct traces of having been long subject to the pressure of the snow-covering, the old stems being pressed closely together, and only the annual shoots growing up into the air.

Peat Bogs. In the course of time sedge bogs usually develop into peat bogs. Gradually, as the peat layer becomes thicker, the dampness

of the surface decreases, the most hygrophilous species disappear and some other species, chiefly mesophilous, take their place. Some of the latter are especially connected with this soil. The most marked species of peaty soil are *Psilopilum lævigatum, Polytrichum gracile, P. juniperinum, Pogonatum polytrichoides, Mnium hornum, Catharinea undulata* (also in warm soil) and *Dicranella cerviculata.* Some species which occur on other soils, but most abundantly on peat, are *Philonotis tomentella, Pogonatum urnigerum, Funaria hygrometrica*, many *Bryum* spp. (especially *B. inclinatum, B. affine, B. arcticum, B. lacustre* and *B. pallens*), *Pohlia nutans, Leptobryum pyriforme, Distichium inclinatum, Ceratodon purpureus* and *Dicranella crispa.* The above-mentioned species are all mesophilous, a few are xerophilous also (for instance *P. juniperinum* and *Ceratodon*), and the majority of them occur also in sandy soil, but in Iceland the peat is often abundantly mixed with fine sand, transported by the wind. The two rare species, *Trematodon ambiguus* and *Pogonatum capillare* var. *dentatum*, have also been found on peat.

The most decided character-plant of peaty soil is *Psilopilum lævigatum*, which occurs everywhere on peat-flats which have been laid bare, and may, for instance, entirely cover the piled-up heaps of cut peat with its numerous capsules, often in association with *Funaria hygrometrica.* Another characteristic vegetation of localities like these consists of extensive bluish-green mats of low-growing, sterile *Pogonatum urnigerum*, interwoven with *Alicularia scalaris.*

The following examples will show the composition of the peat bogs in the different parts of Iceland: —

1. Seydisfjördur. In a peat bog intersected by ditches: *Psilopilum lævigatum, Leptobryum pyriforme, Pogonatum urnigerum, Polytrichum juniperinum* and *P. alpinum* grew abundantly. Intermixed with the above occurred *Bryum inclinatum, B. arcticum, B. purpurascens, Distichium montanum, Ceratodon purpureus, Scapania curta, Alicularia scalaris* and *Lophozia Wenzelii.*

2. Akureyri. Behind the town, at the foot of the mountain, were large expanses of bogs from which great quantities of peat had been removed. The bared flats and the piled-up heaps of cut peat were often entirely covered with *Psilopilum* and *Funaria.* Commonly occurring species were *Polytrichum gracile, P. alpinum, P. juniperinum, Leptobryum pyriforme, Bryum inclinatum, B. affine B. lacustre, B. arcticum, Philonotis tomentella, Ceratodon purpureus, Dicranella crispa, Didymodon rubellus* and *Scapania irrigua.*

3. Grunnavik near Jökulsfjördur. A deep layer of peat, here and there intersected with ditches. The following mosses were observed: *Polytrichum alpinum*, *P. Swartzii*, *Mnium hornum*, *Pohlia nutans*, *P. cucullata* (both common), *Bryum purpurascens*, *Ceratodon purpureus*, *Dicranella cerviculata*, *D. crispa*, *Lophozia quinquedentata* and a few tufts of *Tetraplodon bryoides*. *Psilopilum lævigatum* was found only scantily and after a long search.

4. Lundur in W. Iceland. On a damp peat-flat, the uppermost layer of which was pared off, grew *Dicranella Schreberi*, *Aongstrœmia longipes*, *Bryum lacustre*, *B. inclinatum*, *B. æneum*, *Dichodontium pellucidum*, *Philonotis fontana*, *Meesea trichoides* and *Aneura pinguis*.

The Bryophyte Vegetation of Damp Sandy Soil.

The damp sandy or gravelly ground along streams, inundated only in the case of especially high water-levels, is often covered with a moss carpet of a very mixed composition. Here liverworts play an especially important part, and very frequently pure liverwort associations are met with, or other associations in which the liverworts are almost dominant. They are almost everywhere the same species which are the most abundant constituents of the moss carpet. The following *Hepaticæ* are the most frequent: *Scapania subalpina*, *Alicularia scalaris*, *A. geoscypha*, *Lophozia quinquedentata* *Cephalozia bicuspidata* var. *Lammersiana*, *Anthelia julacea*, *A. Juratzkana*, and, especially in NW. Iceland, *Harpanthus Flotowianus*. Intermixed with the above occur a very great number of species of which the most frequent are *Pellia Neesiana*, *Aneura pinguis*, *Haplozia atrovirens*, *Cephalozia pleniceps*, *Dicranella crispa*, *Dichodontium pellucidum*, *Aongstrœmia longipes*, *Didymodon rubellus*, *Distichium montanum*, *Pohlia commutata*, *P. gracilis*, *Bryum pallens*, *B. inclinatum*, *B. affine*, *Philonotis tomentella*, *P. fontana*, *Pogonatum urnigerum* and *Timmia austriaca*. A few less common species, such as *Blasia pusilla*, *Eucalyx subellipticus* and *Distichium inclinatum*, also belong to this community. Sometimes a moss-covering of another composition is also met with, *Rhacomitrium canescens* often forms extensive mats on wet sandy ground. In North Iceland *Timmia austriaca* and *Philonotis tomentella* are found plentifully in many places on the damp ground above the *Philonotis*-belt, as a rule abundantly mixed with other species. *Dicranella crispa* is also very often found in great quantities on damp sandy

ground. In North-west Iceland the development of the liverwort-mats was especially typical in many places (for instance in Gnupsdalur and near Isafjördur); they consisted chiefly of *Harpanthus Flotowianus*, *Alicularia geoscypha*, *A. scalaris*, *Cephalozia bicuspidata* var. *Lammersiana* and *Lophozia quinquedentata*. Here *Oligotrichum hercynicum* also occurred abundantly in damp sandy localities.

On a somewhat damp, cold flat at the bottom of the fjord Kaldalon, below the Jökull, grew *Pohlia gracilis*, *Hypnum exannulatum* var. *brachydictyon*, *Philonotis tomentella* and *Eucalyx subellipticus*.

The Bryophyte Vegetation near Hot Springs.

Iceland abounds in hot springs: they are not, however, equally distributed over the whole country, but are most numerous in districts in which the most volcanic activity occurs. The majority of these hot springs are found in the south-eastern part of the country, on Reykjanes, around Reykjavik, in the south-western low land, and in several of the valleys of West Iceland, especially in Reykholtdalur. In North Iceland, the district around Mývatn is rich in hot springs, but they are also found scattered singly over the whole of this part of the country. They are absent from East Iceland, but a few occur in North-west Iceland, especially around Isafjardardjup. Groups of hot springs are found in several spots in the inner high land, but the Bryophyte vegetation around these is quite unknown.

The majority of the hot springs of Iceland have a rather high temperature, the water being most frequently at about boiling point. Springs, the temperature of which is not much higher than that of their surroundings, are found for instance around Isafjardardjup near Laugarbol (50°—55°) and Nauteyri (25°—30°), yet no characteristic vegetation had developed there. According to Thoroddsen such springs also occur north of Vatnajökull, and have a temperature which is not many degrees higher than their surroundings.

The hot springs in Iceland may be classified as belonging to two different groups, viz. the Alkaline Springs and the Sulphur Springs.

The Alkaline Springs (thermæ) usually occur in districts where there has been no recent volcanic activity. They contain pure, clear water which often deposits siliceous sinter, and are always surrounded by a luxuriant vegetation. When the temperature reaches

boiling point, they are called in Icelandic "hver" (plur. "hverar"), if the temperature is lower, they are called "laug" (plur. "laugar").

The Sulphur Springs (Icelandic "brennistenshverar") are most numerous in districts where the effect of the volcanic activity is still felt, for instance near Mývatn and in many parts of South Iceland. The water contains sulphuretted hydrogen. These springs deposit sulphur, and the soil around them is greatly decomposed by the acid vapours which arise, and is transformed to red or yellowish clay-masses. Sometimes, as for instance in Reykirdalur, they also deposit siliceous sinter. As a rule, a group of springs consists of either the one or the other kind of spring, occasionally, however, a few springs containing sulphuretted hydrogen may be found together with the alkaline springs. The vegetation around sulphur springs is always very scanty, since only a few species of plants can thrive were they are exposed to hot vapours containing sulphuretted hydrogen.

The "Laugar" near Reykjavik. The vegetation has been described by Ostenfeld (Bot. Tid., vol. 22, pp. 233 et seq.), who has not, however, mentioned the moss vegetation. When I visited the springs in 1909 and 1912 I found no characteristic moss vegetation. Since the warm water had been used for washing purposes the ground surrounding the spring had been much trampled upon, and further downwards towards the warm outlet only the usual bog species were found. Here *Philonotis fontana* alone formed the elongated slender form known also from other hot springs.

The Springs on Biskupstúngur. On the low boggy tract of land between the rivers Bruará and Túngufljót in South Iceland (Biskupstúngur, so called because the old episcopal residence — Skálholt — was situated there), there are, on both sides, along the rivers several hot springs of considerable size, or groups of hot springs of which Thorlákshver and Laugaráshver in the southernmost part, near Skálholt, and Sýdri Reykjahver, further northwards near the Bruará, have been investigated. They all contain pure water free from sulphuretted hydrogen, with the exception of a few small holes near Thorlákshver.

Thorlákshver (Fig. 21) is situated a few kilometres west of Skálholt, close to the east bank of the Bruará. It consists of one larger and several smaller holes, from whence the boiling water flows out and gathers together into a rather large brook, which flows into the Bruará. The vegetation along the sloping

banks of this brook and of the flat boggy surroundings (which are partly influenced by the heat of the soil, partly inundated by the hot water) is very luxuriant. Both around the basins of the springs and along the brook formed by the outlets of the springs, grew a



Fig. 21. Thorlákshver near Skálholt. In the background the river Bruará; behind the fence to the left is a potato field, where the temperature of the ground was about 25 °. The chief outlet of the spring is just behind the small elevation to the left, and the outlet-channel is from the right straight across the foreground. The "peninsula", in the middle of the figure, surrounded by the hot water, is partly covered with *Sphagnum* (the light patch) and partly with *Hypnum*-mats (the dark patch).

broad belt of enormous yellowish brown and pale-green *Sphagnum*-cushions, 25 cm. deep, chiefly formed by *S. imbricatum* (yellowish brown), *S. teres* and *S. cymbifolium* (whitish green) interwoven with *Hypnum stramineum, Hylocomium squarrosum* and here and there with *Acrocladium cuspidatum, Hypnum imponens* and *H. Lindbergii.* The

surface of the *Sphagnum* cushions was usually covered with the orbicular, closely appressed leaves of *Hydrocotyle vulgaris.* The temperature in the *Sphagnum* cushions was rather high, on the surface of the ground as much as 50°, chiefly on account of their feeble heat-conducting power, and the tufts were quite saturated with the moisture from the warm vapours. The *Sphagnum*-belt did not extend so far as to the hot water, but everywhere there was a strip (10—20 cm. broad), nearest the water, covered with low dark-green mats of *Fossombronia Dumortieri*, occasionally intermixed with *Haplozia crenulata* or *Alicularia scalaris.* The same vegetation of *Hepaticæ* was in fact found in all places where the banks were too steep to allow *Sphagna* to gain foothold. The temperature under the *Fossombronia*-covering was, as a rule, about 40° (34°—43°). Where the bank was flatter and on the warm, dry, clayey flats in the neighbourhood of the springs *Archidium phascoides* grew in great masses, and often formed, without intermixture of other species, extensive, dark-green mats, 1—2 cm. deep. It occurred also on the siliceous sinter deposited by the water, and here and there among the *Hepaticæ.* The temperature of the soil under the *Archidium*-mat was almost everywhere about 40°. In the brook formed by the outlet of the spring there was a small island which was partially inundated by the hot water, and here grew a great many large cushions of a peculiar form, a *Barbula fallax* (var. *lævifolia* n. var.), and in one spot, on the slope, in the neighbourhood of the basin, grew *Anthoceros punctatus* together with *Fossombronia.*

Outside the *Sphagnum*-belt the ground was perceptibly warm even for a tolerable distance, and the vegetation there was likewise greatly exposed to the warm aqueous vapours. There *Hypnaceæ*, in particular, grew very luxuriantly on the rather dry substratum. *Hypnum imponens* and *H. Lindbergii* were often almost the only species to be found there, the latter growing in a peculiar, erect form, almost branchless. The temperature of the ground under the *Hypnum*-covering was, as a rule, 25°—30°.

A little below the spring the brook flowed along a steep bank about a metre high. Here the *Sphagnum*-belt disappeared and was replaced by a more mixed vegetation. Lowermost, at a height of about 10 cm. above the water, grew *Fossombronia*, *Haplozia crenulata*, *Alicularia scalaris,* and *Anthoceros,* then followed thick cushions of *Hylocomium squarrosum*, *Hypnum stramineum*, *Thuidium delicatulum*, *Sphagnum teres*, *S. imbricatum* and *Catharinea undulata*,

moreover, *Haplozia sphærocarpa* woven into the *Catharinea*-cushions. All the mosses had developed to an unusual height and vigour, especially *Catharinea* which occurred in a peculiar form (f. *thermophila*) and formed large cushions more than 10 cm. deep. The same vigorous moss vegetation, associated with grasses and sedges, was also found on the flat above the steep bank, as far as the influence of the warm vapours was felt.

Where the banks were low, so that the hot water partially flowed over and mixed with the cold water of the boggy ground, the usual bog or stream-bank vegetation was developed, which nearest to the outlet, in hot water of a temperature of about 25°—30°, consisted of a very slender form of *Philonotis fontana,* associated with some *Hypnum stramineum* and *Catoscopium nigritum.*

The *Hypnum*-belt mentioned above gradually merged into the usual grassland vegetation; most of the species of which (for instance *Rhacomitrium canescens, R. hypnoides*, *Philonotis*, *Mniobryum albicans* and *Hypnum uncinatum*) were also found intermixed with the thermophilous vegetation proper.

A short distance from the main group of the hot springs, on a small, flat piece of ground near the river, there are some small holes, some of which emit boiling water, and some vapours impregnated with sulphuretted hydrogen. The ground around these holes consists of a rather dry, warm (30°—40°), clayey soil, with a very sparse vegetation. *Archidium* is common everywhere: *Fossombronia* often grows around the holes, and here and there on the clayey flats *Riccia crystallina* and *Anthoceros punctatus.*

Laugaráshverir (Fig. 22) are situated in the southernmost part of Biskupstúngur, near the farm Laugarás. At the foot of the slope on which the farm is situated, and in the boggy ground below, there issue several boiling hot springs which, through several channels, unite and form a large brook which flows into the Túngufljót. The vegetation is very much like that in Thorlákshver. Next to the water there is a belt of *Fossombronia*, *Haplozia crenulata*, *Alicularia* and *Archidium* with a ground temperature of as much as 43°; then comes the *Sphagnum*-belt which is composed of *S. subnitens* var. *coerulescens*, *S. teres*, *S. angustifolium*, *S. cymbifolium*, *S. imbricatum* and *S. inundatum* in association with *Hypnum stramineum.* The warm ground between the channels was covered with extensive mats of *Hypnum imponens*, *H. Lindbergii*, *H. stramineum*, *Hylocomium squarrosum*, *Climacium dendroides*, *Thuidium delicatu-*

lum, Calypogeia Trichomanis and *Scapania irrigua. Aulacomnium palustre* was occasionally met with on wetter ground, and *Archidium phascoides, Ditrichum homomallum* and, on a single spot, *Campylopus fragilis* on rather dry, clayey soil. Under the *Hyp-*



Fig. 22. Laugaráshverir. The springs are situated at the foot of a hill: along the outlet-channel and next to the water there is a narrow, dark belt of *Hepaticæ* and *Archidium*, then comes a broad belt of *Sphagnum*-cushions, and outside that (the dark patch in the foreground) are *Hypnum*-carpets.

num-mats there was an almost constant temperature of 32°, and under *Archidium* as much as 46°. On the slope above one of the largest springs *Riccia sorocarpa* grew in abundance, and where steep banks were formed along the outlets grew *Hypnum, Thuidium* and *Catharinea undulata* f. *thermophila;* as was the case near Thorlákshver.

Further northwards near the Bruará is Sýdri Reykjahver. This consists of a large round basin from the centre of which the spring rises, bubbling up at short intervals and ejecting a considerable amount of boiling hot water which flows over the edge of the basin and gathers together into a brook which flows into the river.

On the somewhat higher and eastern side of the basin there is luxuriant grassland, while the lower western side bears a vigorous Bryophyte vegetation. Here, next to the water, grew extensive dark-green and reddish-brown mats of *Alicularia scalaris*, *Haplozia crenulata* and some *Catoscopium nigritum* in which bluish-green patches of *Fossombronia* occurred interspersed, and occasionally rosettes of *Anthoceros punctatus*. Here the temperature of the ground was 25°—27° just below the surface. Then followed a belt, about 2 metres broad, of *Sphagnum papillosum*, *S. cymbifolium* and fruiting specimens of *Polytrichum commune*, with a ground temperature of about 20°.

Lowermost on the steep bank (50—70 metres high) along the outlet grew the usual belt of *Hepaticæ* consisting of *Haplozia*, *Alicularia* and *Anthoceros*, then an abundance of *Oligotrichum hercynicum* interwoven with *Haplozia sphærocarpa*, and uppermost along the edge large cushions of *Hypnum stramineum*, *Hylocomium squarrosum* and some *Sphagnum cymbifolium*, and here and there *Calypogeia Trichomanis*.

In a small bog by the side of the basin, into which the hot water no doubt frequently flowed, grew, in addition to the usual bog vegetation, numerous large cushions of *Sphagnum teres* and *S. inundatum*.

The Hot Springs in Reykholtdalur. Throughout the whole of Reykholtdalur, on both sides of the river Reykjadalsá, there occur very many hot springs, some of which discharge a great amount of water. Near the vicarage of Reykholt rise Dýnkur, Skribla, Snorralaug and other springs, which in part contain sulphuretted hydrogen. Some hundred metres more to the south, on the other side of the river, is Hagindishver, and farther down the valley are other hot springs, of which the largest are Deildatúnguhver, Snældubeinstadahver, Stúrlurreykjahver, Kleppjarnsreykir (probably Grönlund's Kleppholtsreykir) and Vellindishver; the last-mentioned is a fountain (geysir), which is situated on a small rock in the river, and is quite bare of vegetation. The

water in all these latter springs is pure and free from sulphuretted hydrogen.

Near the springs around Reykholt the Bryophyte vegetation is rather scanty, partly on account of the sulphuretted hydrogen, and partly on account of the constant disturbances caused by the traffic and the use of the hot water. *Sphagnum* is practically absent. Along the outlets of the springs liverworts grew almost exclusively. *Fossombronia* and *Blasia pusilla* were very common, the latter grew in the form of flattened rosettes. *Haplozia crenulata* and *Alicularia scalaris* were also frequent.

Around all the other springs in Reykholtdalur there was a luxuriant vegetation of *Sphagna*. *S. papillosum* was especially dominant and occurred in very large cushions, often 20—25 cm. deep, but besides this many other species were found either intermixed or separately in yellow, greenish, red or brownish cushions. The following species have been found on warm ground in Reykholtdalur: *Sphagnum papillosum*, *S. cymbifolium*, *S. angustifolium*, *S. rubellum*, *S. Warnstorffii* and *S. teres* were all common, *S. subnitens* (fr.), *S. acutifolium*, and *S. Dusenii* var. *falcatum* occurred only now and then.

The *Sphagnum* spp. grew partly as a belt along the outlets of the springs, partly on the boggy ground over which the hot water was flowing. Intermixed with these grew everywhere *Hypnum stramineum*, and in many places *Polytrichum commune* with ripe capsules. Near Snældubeinstadahver *Odontoschisma Sphagni* was scantily woven into tufts of *S. rubellum*.

The warm clayey flats next to the water, and especially the steep banks stretching down towards the outlets, were covered with a dense carpet of mosses and liverworts, in which the latter were usually in the majority. The bluegreen rosettes of *Anthoceros* were found almost everywhere, usually together with *Fossombronia*, *Blasia*, *Alicularia scalaris* and *Haplozia crenulata*. In such places *Archidium* also often grew in great abundance.

Grönlund records *Catoscopium nigritum* as occurring abundantly around hot springs in Reykholtdalur, but he has confused it with *Archidium phascoides*. *Catoscopium* is found only exceptionally, and, as it were, accidentally on warm ground, sometimes in a somewhat divergent, slightly tomentose form (var. *Grönlundii* C. J.).

On warm boggy ground the *Sphagnum* carpet was often greatly intermixed with, or partly replaced by, a *Hypnum* vegetation to-

gether with some other Bryophyta. *Hypnum revolvens, H. exannulatum, H. stramineum, H, stellatum, Acrocladium cuspidatum, Scapania irrigua, Pellia Neesiana* and *Alicularia scalaris* were very common, *Aneura multifida* occurred here and there, especially in the *Sphagnum rubellum* cushions. Where the ground was less damp, especially on slightly inclined slopes stretching down towards the hot water, it was covered with a thick carpet of *Hypnum imponens, H. molluscum, H. stramineum, H. revolvens, Hylocomium squarrosum, H. parietinum, H, proliferum* and *Camptothecium lutescens,* in which were scattered cushions of *Sphagnum*, especially *S. rubellum* and *S. teres.* Sometimes *Preissia commutata* also could form bluish-green patches, about a metre in breadth, usually intermixed with some *Hypnum molluscum.*

Stúrlurreykjahver is situated on a slightly inclined slope stretching down towards the river Reykjadalsá. At the top, near the spring, there is the usual *Sphagnum* vegetation which, farther downwards where the ground on both sides of the outlet of the spring is rather boggy, is replaced by a greatly mixed vegetation, composed principally of *Hypnum imponens, Hylocomium squarrosum, Polytrichum gracile, Dicranum scoparium* var. *orthophyllum, Calypogeia Trichomanis* and *Alicularia scalaris.* Alternating with the *Hypnum* carpet, extensive, dark-green mats of *Archidium* are found. The surface temperature of the ground under the *Sphagnum* carpet was, as a rule, 40°, whilst under the *Hypnum-Archidium* carpet there was an almost constant temperature of 37°. On stones in the tepid water, the temperature of which was at this spot 34°, grew large cushions of *Dicranella squarrosa.*

Kleppjarnsreykir is undoubtedly the same spring that Grönlund (1877, p. 350) calls Kleppholtsreykir. He states that at this spring the same two species of *Sphagnum* occur that are found near Túnguhver, and that near the spring and its outlet, among others, "*Distichium capillaceum, Mnium serratum, Hypnum ochraceum* and *Catoscopium nigritum*" are found. The two last-mentioned have been wrongly determined, and the two first do not at any rate belong to the species characteristic of the warm ground.

The outlet has for a tolerably long distance steep banks, about half a metre high, which are, at the foot, covered with the usual liverwort-vegetation: *Haplozia crenulata, Fossombronia, Anthoceros, Alicularia* and *Archidium.* The uppermost part is covered with a dense moss-carpet consisting of *Hylocomium squarrosum, H. proli-*

ferum, Hypnum imponens, Mnium hornum, M. undulatum, M. serratum, Fissidens osmundoides and *Enthostodon ericetorum*. On a stone partly inundated by the hot water, which had a temperature of about 50°, *Fissidens osmundoides, Blindia acuta, Dicranella squarrosa, Enthostodon ericetorum, Anthoceros punctatus, Aneura multifida* and *Scapania irrigua* grew intermixed.

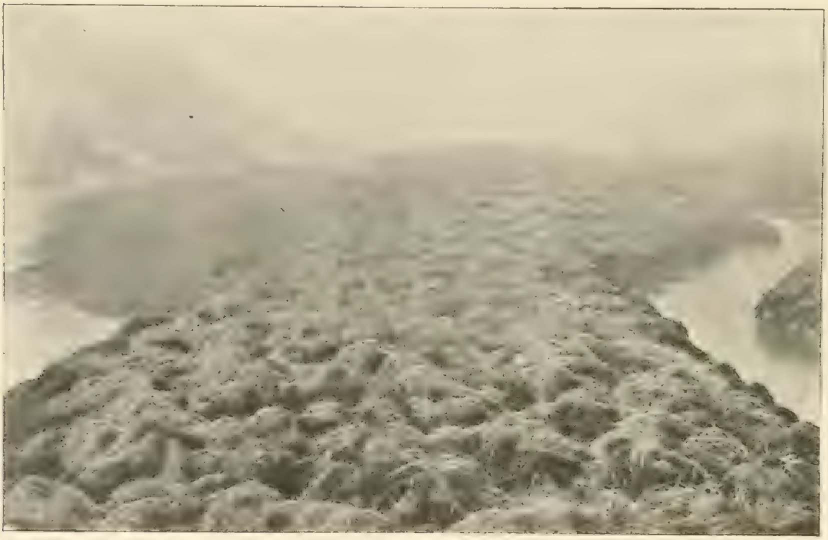


Fig. 23. Deildatúnguhver. To the left is the slope with the hot springs. The part in the middle is saturated with the hot water and covered with *Sphagnum papillosum, Polytrichum commune* and *Hydrocotyle*.

Deildatúnguhver (Grönlund's Túnguhver) (Fig. 23) is situated north of the river and opposite to Kleppjarnsreykir. It is mentioned by Grönlund (1877, p. 349), who states that the surface temperature of the ground at the top of the hill was 23° R, and that there *Polytrichum commune, Sphagnum cymbifolium, S. cuspidatum* and a *Campylopus (C. flexuosus)* — not determined with certainty — grew in the warm ground. Deildatúnguhver is one of the hot springs of Iceland which discharge the greatest amount of water, and consists of a row of holes at the foot of a hill 6—8 metres high, whence an enormous quantity of water and steam is ejected with a great noise. The masses of steam, which can be seen for miles, enshroud the surroundings of the spring with so dense a cloud that it is hardly possible to approach without getting soaked through. Below the hill the water

gathers into a broad brook which flows into the river. The whole hill, which consists of reddish clay, is warm throughout, and at the top the temperature was 36°—40° just below the surface of the ground.

On the slope stretching down towards the springs *Blasia pusilla* grew abundantly, occasionally in company with *Fossombronia Dumortieri*. The dry ground on the top of the hill was covered with large patches of *Campylopus flexuosus* and *Hypnum imponens* intermixed with scattered tufts of *Catharinea undulata* and *Oligotrichum hercynicum* and entirely interwoven with *Gymnocolea inflata*. At the foot of the hill, but on the opposite side to that on which the springs lie and where the ground was damper, grew, in addition to the above-mentioned species, *Sphagnum cymbifolium* and *Polytrichum gracile*. Here some 5—6 small plants of the fern *Blechnum spicant* were also found.

The warm brook below the hill divides into several branches, which flow round some large islands saturating them with the warm water. Here *Sphagnum papillosum*, *S. angustifolium* and *Polytrichum commune* grew in enormous cushions, which were everywhere covered by the orbicular leaves of *Hydrocotyle vulgaris* and entirely enshrouded in hot vapours.

Geysir. On a low mound about one kilometre long and about 1/2 a kilometre broad, situated about 100 metres above sea-level, there are a great number of hot springs (about 40) besides the well-known Great Geysir. The majority of these springs consist of a larger or smaller hole, but sometimes of a basin, several metres in diameter, in which the boiling water usually reaches to the upper edge and flows over the somewhat raised rim, or is ejected at shorter or longer intervals. The soil consists of reddish clay, or nearest to the springs — especially to Geysir — of siliceous sinter. The water in the majority of the springs smells slightly of sulphuretted hydrogen. The whole district around the springs is warm, and in many places the temperature is so high that the tenants of the neighbouring farm (Laug) bake their bread by putting the dough into a pot and burying it about 30—40 cm. below the surface of the ground.

The siliceous sinters are quite bare of vegetation. The warm clay-flats situated on a higher level are, as a rule, dry, and either bear a greatly scattered Bryophyte vegetation or are quite bare. Under the scattered, low cushions of *Ditrichum homomallum*, *Archi-*

dium and *Fossombronia* which were growing here, the thermometer showed as high a temperature as 34° on the surface of the ground. On a slightly damp flat which was covered with a low-growing, dense form of *Climacium dendroides*, the surface temperature of the ground was 43°.

In the more low-lying tracts, where the ground was rather damp, or partially inundated with hot water, there had, in several places, developed a luxuriant vegetation of phanerogams and mosses, which was, however, often much trodden down. Here, in the boggy parts, grew a low vegetation of *Carex-Viola palustris*, greatly mixed with Bryophyta, of which the following species, which grew intermixed, were observed: *Hypnum stramineum*, *H. sarmentosum*, *H. imponens*, *Hylocomium squarrosum*, *Sphagnum cymbifolium*, *Catharinea undulata*, *Calypogeia Trichomanis*, *Alicularia scalaris*, *Haplozia crenulata*, *Scapania irrigua*, *Aneura pinguis* and an undeterminable *Pohlia*. On damp clayey flats *Archidium*, *Fossombronia Dumortieri*, *Haplozia crenulata* and *Alicularia scalaris* formed low, dense mats in which *Anthoceros punctatus* occasionally occurred in small rosettes.

Below Great Geysir, *Hypnum chrysophyllum* grew on a clayey flat inundated with tepid water.

Laugarvatnshverir. By the shore of lake Laugarvatn, below the farm of the same name and along the water's edge, there is a row of springs containing boiling water saturated with sulphuretted hydrogen. The surrounding ground which consists of black basalt gravel is, owing to its exposed situation, quite bare of Bryophyte vegetation; and of higher plants only a few specimens of *Polygonum Persicaria* were found. By the northernmost of the springs only, which is situated at some distance from the lake shore, a warm, damp clayey flat was covered with a carpet of *Sphagnum cymbifolium*, *S. Girgensohnii*, *Polytrichum commune*, *Hylocomium squarrosum*, *Hypnum stramineum*, *Archidium phascoides*, *Pohlia grandiflora* ♀, *Aongstrœmia longipes*, *Gymnocolea inflata*

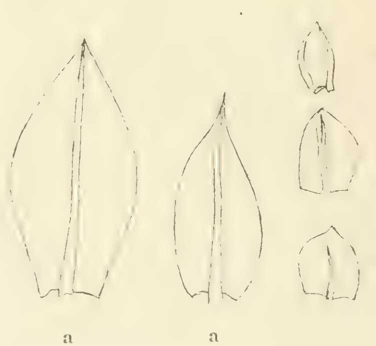


Fig. 24. *Bryum* sp. *a*, Older leaves developed before the plant was inundated with hot water; *b*, leaves from shoot developed in hot water (Geysir).

c. coles., *Haplozia sphærocarpa, H. crenulata, Alicularia scalaris* and *Scapania irrigua.*

At **Englandshverir,** some small hot springs which rise in Lundurreykjadalur, there was only opportunity for quite a short stay on the journey past. Here, on the warm ground along the outlet of the springs the following species were observed: *Sphagnum teres, Hypnum imponens, Catharinea undulata, Fissidens osmundoides, Enthostodon ericetorum, Catoscopium nigritum, Archidium phascoides, Aneura pinguis, Pellia Neesiana and Fossombronia Dumortieri.*

The **Hot Springs near Reykir.** In the south-western part of Iceland, around the farms Reykir and Reykirfoss, about 45 kilometres south-east of Reykjavik, there is a very large group of hot springs which stretches towards the north and north-west, through the valleys, right up upon Hengill to a height of 400—500 metres above sea-level. To this group must also be reckoned the hot springs near Kolvidarhol and on Hellisheidi. The majority of the springs are situated around the farm Reykirfoss, and north of the latter, on both sides of the river from a height of about 50 to 90 metres above sea-level; most of them are in the neighbourhood of the river, and are in part situated directly upon the banks of the latter, several, however, lie upon the slope of Reykjafjall, up to about 100 metres above sea-level. Where the naked basalt does not protrude, the ground around the springs consists of greyish-white siliceous sinter almost bare of vegetation, and large tracts of it are warm and, so to speak, perforated like a sieve with numerous hot springs of all possible sizes. These appear in the form of (1) steaming holes (fumaroles) which range in size from quite fine pores to rather large funnels, (2) fountains (geysirs) which at short intervals eject boiling water ranging from quite a slender jet one foot in height to mighty columns of roaring water from 10 to 15 feet in height (Little Geysir), (3) mud-pools with bubbling, bluish-grey mud which is often ejected to a distance far beyond the surroundings of the pool, and (4) boiling basins or cauldrons which may measure 6—8 metres in diameter, and either have a quiet surface or boil up at short intervals, so that the water partially flows over the edge of the basin. The steam is everywhere impregnated with sulphuretted hydrogen, with the result that the vegetation is very poor and homogeneous. The luxuriant *Sphagnum*-vegetation known from the alkaline springs does not occur near these springs. Around these steaming holes,

geysirs and mud pools the ground is usually quite bare as far as the boiling water and the mud are able to spurt.

Near the boiling basins which occur in great number and generally have a diameter of 2—4 metres, the ground forms, as a rule, a slope on the one side with an angle of 25°—40°, whilst on the opposite side the water flows down a gentle slope which stretches as far as to the river. The ground for the first 10—20 cm. of this slope, which corresponds approximately to the different water-levels, is of a greyish-white colour and quite bare of vegetation. Then comes a belt of varying breadth formed of liverworts which, next to the water, are black or of a brownish black, above this of a reddish-brown or brownish-green, and at the top, green. This liverwort-carpet was everywhere composed of *Gymnocolea inflata*, *Haplozia crenulata*, occasionally also *Alicularia scalaris* f. *rufescens* and at the top *Cephalozia bicuspidata*. The temperature under the moss-covering was on an average 20°—25°.

Polytrichum commune grew scattered in the liverwort carpet, from which its bluish-green tops protruded several centimetres, but frequently it also formed large growths above the liverworts, partly interwoven with the latter. Only very few phanerogams were able to grow there, usually only flowerless specimens of *Viola palustris*, the short-stemmed leaves of which rested on the liverwort carpet. Besides the above-mentioned Bryophyta several others were found on the warm clayey flats, although far more scantily. *Anthoceros punctatus*, *Fossombronia Dumortieri*, *Blasia pusilla* and *Archidium phascoides* grew here and there. In several places *Oligotrichum hercynicum* occurred in tufts a few mm. high, and in one single locality *Alicularia geoscypha* and *Aongstrœmia longipes* were found in company with it. On warm ground between loose blocks of rock, at an altitude of about 260 metres, the following were found among others: *Polytrichum commune*, *Hylocomium loreum*, *Plagiothecium elegans* and *Diplophyllum albicans*.

In the neighbourhood of the farm Reykirfoss, on the western side of the river, and at the edge of the lava field, there is a rather large spring with pure water of a temperature of about 37°. Here the blocks of stone in the water were quite covered with *Pellia Neesiana*, in the tufts of which *Veronica Anagallis* had taken root.

Where the boiling water flowed over the slightly inclined slopes, it deposited greyish-white siliceous sinter, upon which grew blue-green algæ as soon as the water had cooled down to 60°—70°. The

Bryophyta appeared first at the edge of the outlet of the spring where the temperature was 25°–40°. The vegetation here resembled that of wet, cold ground, and was usually composed of *Philonotis fontana, Mnium Seligeri, Hypnum stramineum, Catoscopium nigritum,* and in a single spot of some *Sphagnum angustifolium.* On drier, warmer ground *Hypnum imponens* was found here and there in company with *Hypnum stramineum, Hylocomium squarrosum, Archidium phascoides,* etc.

Of the hot springs situated at higher levels only a few have been investigated. In the neighbourhood of Kolvidarhol, at an altitude of about 350 metres, on the warm ground around some holes whence issued vapours impregnated with sulphuretted hydrogen and where sulphur had been deposited, the following species were growing: *Gymnocolea inflata, Haplozia crenulata, Fossombronia Dumortieri, Aneura pinguis, Archidium phascoides* and *Polytrichum commune.* Here *Gymnocolea inflata* was not strictly confined to the warm ground, but appeared rather to prefer clay, as it also grew on clayey flats which had probably been warm previously, but were now quite cold.

The same species together with *Blasia pusilla* grew also in Reykjadalur (at an altitude of about 260 metres) on the damp base of a warm slope from which vapours, containing sulphuretted hydrogen, and water issued sparsely from numerous small holes. Near some mud-pools on Hellisheidi only *Gymnocolea inflata* and *Haplozia crenulata* occurred.

The **Sulphur Springs on Reykjanes** — which I myself had no opportunity of visiting — have been described by Ostenfeld (Bot. Tids., vol. 22, p. 239). They occur in two groups, near Reykjanes lighthouse and also near Krisuvik.

The Solfataras near Reykjanes lighthouse form a large group with numerous orifices of discharge, partly mud-pools, partly steaming holes, everywhere around which the ground is warm (20°—30°). Near the outlet of the largest mud-pool, Gunna, the damp ground, which had a temperature of about 30°, was covered with *Haplozia crenulata* to which, along the margin, came several other species, viz. *Fossombronia Dumortieri, Archidium phascoides* (recorded by Ostenfeld as *Pohlia nutans* v. *filicaulis*), *Trichostomum littorale* and *Bryum ventricosum,* all of which, however, only occurred sparingly. Around the steaming holes grew *Riccia bifurca, Preissia commutata, Fossombronia Dumortieri, Archidium phascoides,*

Bryum ventricosum, *Fissidens osmundoides* and *Philonotis fontana*.

The Sulphur Springs near Krisuvik are, according to Ostenfeld, rather bare of vegetation, and he mentions only *Haplozia crenulata* as growing near a few of these. The collections contain also *Gymnocolea inflata* and *Polytrichum commune* which were gathered here by Steenstrup, so probably the same species occur on this spot as are, for instance, to be found near Kolvidarhol.

In the remaining part of Iceland the vegetation of the warm ground has hardly been investigated at all. During my stay at Mývatn in 1909 continual rain and fog prevented me from making a closer investigation of the numerous sulphur springs which occur there. The warm clayey flats were mostly quite bare, only around a single steaming hole, where the temperature of the surface was about 40°, grew *Riccia bifurca*, *Haplozia crenulata* and *Fossombronia Dumortieri*.

A moss-cushion from one of the Solfataras near Kverkfjall, (Eyafjallajökul) collected by Andr. Lundager, consisted of *Philonotis fontana* and *Riccia bifurca*.

By comparing what is known regarding the moss vegetation of warm ground, it is seen that the composition of the vegetation is dependent on the chemical nature of both the water and the escaping vapours, and also on conditions pertaining to soil.

Where the water is free from sulphuretted hydrogen, or where it, at most, contains a trace of it, the *Sphagnum* vegetation is very luxuriant, especially when the surroundings of the spring are boggy, as is the case in Biskupstúngur and near most of the springs in Reykholtdalur. The condition for the formation of a continuous Sphagnetum, in addition to a warm, damp substratum, is an abundant development of vapour, which envelops the moss-cushions in a damp, warm atmosphere. The most frequent species is *S. papillosum*, which often constitutes the bulk of the *Sphagnum* carpet, in association with *S. cymbifolium*, *S. angustifolium* and *S. teres*, frequently replaced by, or intermixed in patches with, some other species. Scattered in the *Sphagnum* carpet grew, as a rule, a very vigorous, fruiting form of *Polytrichum commune*, and usually also *Hypnum stramineum*, *Hylocomium squarrosum* or *Acrocladium cuspidatum*.

Outside the *Sphagnum*-belt there occurs, on warm, boggy ground, a moss carpet interspersed with *Carex* spp. and other flowering plants, and chiefly composed of *Hypnaceæ*, occasionally also of *Philonotis*

fontana, Aulacomnium palustre or of an abundance of species intermixed. The commonest of these species are: *Hypnum imponens* and *H. Lindbergii,* which are often the most abundant constituents of the carpet, *H. stramineum, Hylocomium squarrosum, Acrocladium cuspidatum, Thuidium delicatulum,* and numerous other bog-mosses such as *Hypnum revolvens, H. molluscum, Catoscopium nigritum, Fissidens osmundoides, Scapania irrigua, Pellia Neesiana, Aneura pinguis,* etc. Especially the first six species, however, occur everywhere in abundance, and often attain an unusual size and development.

As an intermixture in this moss carpet some species, for instance *Mnium hornum, Catharinea undulata* and *Polytrichum gracile,* are occasionally met with which partly occur also in other localities and are partly characteristic of warm ground, and in Iceland only occur in such. To the latter group belong — in addition to *Hypnum imponens,* which is rare elsewhere — *Enthostodon ericetorum, Calypogeia Trichomanis, Aneura multifida* (found scantily in one spot on cold boggy ground) and *Odontoschisma Sphagni.* Some species develop special warm-soil forms: *Catharinea undulata* f. *thermophila* is exceedingly vigorous, as much as 10 cm. high, with long, extremely wavy, secund leaves right up from the base. *Philonotis fontana* becomes thread-shaped in warm ground, with long, branchless, barely tomentose shoots (Fig. 8), *Hypnum Lindbergii* develops a similar form with almost branchless, erect stems with scattered leaves, and *Hypnum imponens* is also, as a rule, much elongated and slightly branched. Comp. further *Bryum* sp. (Fig. 24). On drier, clayey ground the *Hypnum* carpet is replaced by other species. *Archidium phascoides* is extremely common, and often forms extensive growths both near alkaline springs and near springs containing sulphuretted hydrogen. Here *Campylopus flexuosus, C. fragilis, Oligotrichum hercynicum, Catharinea undulata, Gymnocolea inflata* and several other species are also to be found.

In damp clayey soil, especially along the outlets of the hot springs, both where the water is pure and where it contains sulphuretted hydrogen in small quantities, without however depositing sulphur, a low Bryophyte carpet occurs composed of specie—smostly *Hepaticæ* — the majority of which are only met with in warm soil. *Haplozia crenulata, Fossombronia Dumortieri* and *Oligotrichum hercynicum* are also common. *Preissia commutata* is common in Reykholtdalur, *Alicularia geoscypha* and *Aongstrœmia longipes* and a few other species occur here and there.

Where the surroundings of the spring consist of siliceous sinter, as is the case with the majority of the springs of the Geysir-complex, and in Reykirdalur, all species of *Sphagnum* are absent, or are to be found only as a subordinate component, and the moss vegetation is, on the whole, scanty, and consists of the same species as are to be found on clayey soil, together with some *Hypnaceæ*, *Philonotis*, etc. on damper soil.

Near the Sulphur Springs proper the Bryophyte vegetation is extremely scanty, and the ground is often quite bare of vegetation as far as the hot vapours extend. *Sphagnum* and *Hypnaceæ* are entirely absent, whereas the majority of the *Hepaticæ* are to be found, especially *Haplozia crenulata*, *Fossombronia Dumortieri*, *Gymnocolea inflata*, *Alicularia scalaris*, *Preissia commutata* together with *Archidium phascoides*, *Polytrichum commune* and a few other mosses. *Riccia* spp. (*bifurca*, *sorocarpa* and *crystallina*) belong specially to the dry, warm ground in the neighbourhood of sulphur springs.

The following species have been found on warm ground:

1. Species which occur only on warm ground.

Riccia crystallina L. Thorlákshver.

Riccia sorocarpa Bisch. Laugaráshverir.

— *bifurca* (Hoffm.) Lindenb. Myvatn; Reykjanes: Kverkfjäll.

Anthoceros punctatus L. Common.

Fossombronia Dumortieri (Hüben.) Lindb. Everywhere.

Calypogeia Trichomanis (L). S. F. Gray. Mývatn; Reykholtdalur; Englandshverir; Sydri Reykjahver; Geysir.

Odontoschisma Sphagni (Dicks.) Dum. Reykholtdalur.

Sphagnum imbricatum Hornsch. Thorlákshver; Laugaráhverir.

Sphagnum cymbifolium (Ehrh.) Hedw. Common.

Sphagnum Dusenii C. Jens. v. *falcatum* Reykholtdalur.

Archidium phascoides Brid. Very common everywhere.

Entosthodon ericetorum (Bals. et de Not.) C. M. Reykholtdalur; Englandshverir.

Campylopus flexuosus (L.) Brid. Reykholtdalur.

Campylopus fragilis (Dicks.) Br. eur. Laugaráshverir.

Barbula fallax Hedw. var *lævifolia* n. var. Thorlákshver.

Catharinea undulata (L.) Ehrh. f. *thermophila* Thorlákshver; Laugaráshverir.

2. Species which are mainly distributed over warm

ground and only occur as an exception in other localities.

Aneura multifida (L.) Dum. Reykholtdalur.

Haplozia crenulata (Sm.) Dum. Near all hot springs.

Gymnocolea inflata (Huds.) Dum. Reykholtdalur; Reykirdalur; Krisuvik.

Sphagnum papillosum Lindb. Very common.

S. angustifolium C. Jens. Common near alkaline springs.

S. inundatum Russ. Laugaráshverir; Sýdri Reykjahver.

Hypnum imponens Hedw. Common near most hot springs.

Haplozia sphærocarpa (Hook.) Dum. and *Oligotrichum hercynicum*. These two species have a most peculiar distribution.

Haplozia has been found near several hot springs in SW. Iceland and also on mountain heights near Isafjördur.

Oligotrichum hercynicum is common near most alkaline springs, and also near a few containing sulphuretted hydrogen. It is, moreover, common on rocky flats at an altitude of 400—500 metres, and also in NW. Iceland; but is otherwise very rare.

3. Species which are also common in other localities.

Aneura pinguis Dum. Common.

Pellia Neesiana (Gottsche) Limpr. Common.

Blasia pusilla L. Near many springs.

Preissia commutata (L.) N. v. Es. Reykholtdalur; Reykjanes.

Alicularia scalaris (Schrad.) Corda. Very common everywhere.

— *geoscypha* de Not. Reykirdalur.

Cephalozin bicuspidata (L.) Dum. Reykirdalur.

Scapania irrigua (Nees) Dum. Frequent.

Sphagnum subnitens Russ. et Warnst. Laugaráshverir; Reykholtdalur.

S. teres (Schimp.) Ångstr. Very common.

S. rubellum Wils. Reykholtdalur.

S. Warnstorffii Russ. Reykholtdalur.

S. Girgensohnii Russ. Laugarvatnshverir.

Dicranella squarrosa (Schrad.) Sch. Reykholtdalur.

Fissidens osmundoides (Sw.) Hedw. Frequent near alkaline springs.

Blindia acuta (Huds.) Br. eur. Reykholtdalur.

Ditrichum homomallum (Hedw.) Hampe. Geysir; Reykirdalur.

Trichostomum littorale Mitten. Reykjanes.

Catoscopium nigritum (Hedw.) Brid. Frequent.

Mnium undulatum (L.) Weiss. Reykholtdalur.

Mnium hornum L. Common near alkaline springs.

Mnium serratum Schrad. Reykholtdalur.

Aulacomnium palustre (L.) Schwägr. Common, several places in abundance.

Philonotis fontana (L.) Brid. Very common, often in masses.

Catharinea undulata (L.) W. et M. Common.

Polytrichum commune L. Common.

— *gracile* Dicks. Reykholtdalur.

Thuidium delicatulum (L.) Mitten. Frequent.

Hypnum molluscum Hedw. Abundant near all the hot springs in Reykholtdalur.

Hypnum Lindbergii (Lindb.) Mitten. Common everywhere.

Hypnum revolvens Sw. Common near many springs, especially in Reykholtdalur.

Hypnum chrysophyllum Brid. Geysir.

— *sarmentosum* Whlb. Geysir.

— *stramineum* Dicks. Very common everywhere.

— *exannulatum* Gümb. Reykholtdalur.

Acrocladium cuspidatum (L.) Lindb. Common.

Climacium dendroides (L.) W. & M. In many places, plentiful near Geysir.

Hylocomium squarrosum (L.) Br. eur. Common everywhere.

— *proliferum* (L.) Lindb. Common in Reykholtdalur.

— *parietinum* (L.) Lindb. In several places plentiful.

Besides the species mentioned in the above list, several other species are, however, also found as more casual intermixtures in the moss carpet, especially species from boggy soil and from grassland, for instance *Rhacomitrium canescens*, *R. hypnoides* and *Hypnum uncinatum*.

Mesophilous Bryophyte Formations.

The Bryophyta, as a rule, play a less prominent part in the plant-covering of soil of a middle degree of dampness, than in that of wet soil, because in the former the higher plants find more favourable conditions of life, and the Bryophyta are consequently driven more into the background and occur only as ground vegetation between the higher plants. Several other conditions are, however, of essential importance in this connection, for instance conditions pertaining to the light, the direction of the slope and the snow-covering. Bryophyta bear shade better than do the higher

plants and consequently develop better than the latter in localities which are less favourable as regards the light, for instance, on the northern sides of clefts and in caves. In valleys southern slopes are covered with grass or other herbaceous plants, while northern slopes are moss-grown. In the narrow tuff-clefts of South Iceland the sides are often covered with a luxuriant moss carpet consisting of *Hylocomium* spp., *Thuidium*, *Polytrichum*, etc. Here the snow-covering no doubt also plays an important part, since by remaining until far into the spring, it checks the growth of the higher plants far more than it does that of the mosses.

Grassland is mostly knolly, and the mosses grow abundantly on the ground between the grasses. Here it is especially species such as *Hypnum uncinatum*, *Hylocomium squarrosum*, *Climacium dendroides*, *Polytrichum alpinum* and *Rhacomitrium canescens* which are the most abundant constituents of the vegetation, but in addition to these many other species occur, for instance *Catharinea undulata*, *Timmia austriaca*, *Tortella tortuosa*, *Dicranum congestum*, *Ditrichum flexicaule*, *Distichium montanum*, *Bartramia ityphylla*, *Rhacomitrium hypnoides*, *Hylocomium* spp., *Hypnum Lindbergii* and *Lophozia quinquedentata*. The composition of the vegetation varies according to the degree of dampness, therefore, we sometimes find species from boggy soil and sometimes xerophilous species of heathy soil intermixed in greater and smaller quantities.

Grass-slope and Herb-slope[1]. On the herb-slope the Bryophyta are very scantily represented. On the grass-slope the bottom is covered with a more or less dense carpet of mosses and liverworts in which the chief species are *Hylocomium proliferum*, *H. parietinum*, *H. squarrosum*, *H. rugosum*, *H. loreum*, *H. triquetrum*, *Hypnum uncinatum*, *Climacium dendroides*, *Camptothecium lutescens*, *Thuidium delicatulum* (S. Icel.), *Mnium affine*, *Timmia austriaca*, *Polytrichum alpinum*, *Pogonatum urnigerum*, *Rhacomitrium canescens*, *R. hypnoides*, *Ditrichum flexicaule*, *Lophozia lycopodioides* and *Plagiochila asplenioides*, but besides these, many other species occur as a more casual admixture.

On a stony substratum with a thin layer of soil mosses are dominant, and phanerogams grow scattered in the moss carpet. A "moss-slope" is then developed which, as a rule, is composed of the same species as those found on the grass-slope, most frequently

[1] See footnote in Thoroddsen's Physical Geography of Iceland, ante p. 330.

Hypnum uncinatum, Hylocomium spp., *Rhacomitrium* spp. and *Thuidium delicatulum* (S. Icel.). These are often associated with several of the xerophilous species, such as *Dicranum scoparium, Frullania Tamarisci, Ptilidium ciliare* and *Antitrichia curtipendula*, through which are formed transitional stages to the moss-heaths mentioned below. In South Iceland several of the southern species have their greatest distribution on well-sheltered, grass-covered slopes with a southern exposure, for instance *Scleropodium purum, Eurhynchium piliferum, E. Stockesii, Thuidium tamariscinum, T. Philiberti, T. delicatulum* and *Mnium undulatum*.

Birch coppices grow on a rather dry substratum. The wood-floor is either occupied by grassland or by heather moor, and the Bryophyte vegetation does not differ in any respect from that which occurs on a corresponding substratum outside the coppices. Most frequently it consists of *Hylocomium* spp. in association with *Hypnum uncinatum* and *Rhacomitrium* spp. (*R. canescens* and *R. hypnoides*).

Bryophyta grow only rarely and scantily on tree trunks. *Radula complanata* and *Frullania dilatata* have been found in one single spot on a tree trunk, but, as a rule, it is some ground species or other which grows a little way up on the slanting trunks. In some few places *Rhacomitrium fasciculare* has been found on tree trunks to which it had spread from neighbouring stones.

Laugardalsskógur. This coppice, which is open and of about a man's height, has its floor mostly covered with heather moor, with a thick moss carpet composed of *Hylocomium parietinum, H. proliferum, H. triquetrum, H. squarrosum, Hypnum uncinatum* and *Rhacomitrium hypnoides*, occasionally *Dicranum scoparium, Ptilidium ciliare, Lophozia lycopodioides* and *L. quinquedentata* also occurred. Of quite a similar composition was the moss carpet in almost all the coppices of South and West Iceland. A few other species also belong to this community, but are more rarely met with, for instance *Bryum cæspiticium, Pohlia nutans, P. acuminata* and *Lophozia barbata*.

Hallormstadaskógur (East Iceland). The floor here rather varies in nature, and is sometimes covered with heather moor and sometimes with grassland or peat. In heathy soil *Hylocomium* spp. were dominant in connection with *Rhacomitrium hypnoides*, while especially *Hypnum uncinatum* grew abundantly on grassy ground. Where it was very shady *Timmia austriaca* grew abundantly on knolls.

Of other species the following were observed: *Pohlia nutans*, *P. cruda*, *Bryum cæspiticium*, *B. affine*, *Bartramia ityphylla*, *Polytrichum alpinum*, *P. juniperinum*, *Distichium montanum*, *Ditrichum flexicaule*, *Sælania cæsia*, *Tortula subulata*, *T. ruralis*, *Dicranum scoparium*, *Ptilidium ciliare*, *Lophozia lycopodioides*, *L. quinquedentata*, *Frullania Tamarisci* and *Scapania curta*.

Birch coppice in Kaldalon (NW. Iceland). The south-western slope was covered with a low-growing and very dense birch coppice with a ground vegetation of numerous flowering plants (*Geranium silvaticum*, *Bartsia alpina*, *Taraxacum*, etc.) and a Bryophyte carpet of *Hylocomium proliferum*, *H. parietinum*, *H. squarrosum* and *Hypnum uncinatum* intermixed with *Dicranum scoparium*, *D. fuscescens*, *Pogonatum urnigerum*, *Polytrichum alpinum*, *Lophozia lycopodioides*, *L. quinquedentata*, *L. Flœrckei*, *L. ventricosa*, *Cephalozia bicuspidata* and *C. pleniceps*. In open spots *Pohlia nutans* was very common, and *Polytrichum gracile* occurred frequently on knolls on the floor of the coppice.

Of a similar composition is the moss carpet of all the coppices of NW. Iceland. In several spots *Dicranum majus* and *Hylocomium triquetrum* also occurred.

Bryophyta of Soil recently laid bare. On slopes, on the sides of clefts, on soil-covered rock-ledges and, on the whole, in all places where by weathering, by land-slips or by the action of water new soil is produced, which has not yet become inhabited by higher plants, a luxuriant Bryophyte vegetation occurs, which C. Jensen (1910, p. 258) includes in a group within the mesophilous associations, under the name "Moosvereine des frischen Erdbodens". A number of species are here met with, especially of the commonly occurring mesophilous forms, but also, several species belonging to damp sandy soil and to rocks. It is especially liverworts and the acrocarpous mosses which are represented here, while the pleurocarpous mosses occur but scantily. It is a condition for the growth of mosses that there is an abundant snow-covering during winter, which affords them protection from desiccation by wind.

The composition of the moss-covering varies greatly according to the prevailing degree of humidity, and the local conditions.

In such localities as those mentioned above the following Hepaticæ occur: — *Aneura pinguis*, *Marchantia polymorpha*, *Gymnomitrium concinnatum*, *Alicularia scalaris*, *A. geoscypha*, *Lophozia*

quinquedentata, *L. ventricosa*, *L. Mülleri*, *L. alpestris*, *Cephalozia bicuspidata*, *Cephaloziella Hampeana*, *Blepharostoma trichophyllum*, *Anthelia julacea*, *A. Juratzkana*, *Scapania subalpina*, *S. curta*, more rarely *Preissia commutata*, *Blasia pusilla*, *Eucalyx subellipticus*, *Lophozia excisa*, *L. heterocolpos* and *Lophocolea minor*. The following are the commonest mosses: — *Dichodontium pellucidum*, *Dicranella crispa*, *Distichium montanum*, *Didymodon rubellus*, *Tortula subulata*, *Desmatodon latifolius*, *Tortella tortuosa*, *T. fragilis*, *Schistidium apocarpum*, *S. gracile*, *Encalypta ciliata*, *E. rhabdocarpa*, the majority of the species of *Bryum*, *Leptobryum pyriforme*, *Pohlia commutata*, *P. cruda*, *Mniobryum albicans*, *Mnium punctatum*, *Bartramia ityphylla*, *Philonotis tomentella*, *Timmia austriaca*, *Pogonatum urnigerum*, *Myurella julacea*, *M. tenerrima*, *Brachythecium reflexum*, *Plagiothecium Roeseanum*, *Hypnum hamulosum*, *H. callichroum*, *H. uncinatum*, *Hylocomium loreum*. Some rare species, for instance *Eurhynchium strigosum* var. *præcox*, *Heterocladium squarrosulum*, *Distichium inclinatum* and *Weisia viridula* are found especially in such localities as those mentioned above.

Xerophilous Bryophyte Associations.

Heaths.

The heath formation is extensively distributed about Iceland. It occurs especially on dry slopes, and hardly ascends higher than about 300—400 metres above sea-level, where it is succeeded by the rocky-flat association.

Heather-moor (H. Jónsson, 1900, p. 69). The chief heath-forming plants are *Empetrum nigrum*, *Vaccinium uliginosum*, *V. Myrtillus*, *Arctostaphylos uva ursi*, *Betula nana* and, especially in E. Iceland, *Calluna vulgaris*. Mosses and liverworts often grow abundantly on the ground. The Bryophyte carpet is chiefly composed of *Hylocomium* spp. (especially *H. proliferum* and *H. parietinum*), *Rhacomitrium hypnoides*, *R. canescens* and *Hypnum uncinatum*, but *Dicranum* spp. (*D. scoparium*, *D. fuscescens* and others), *Lophozia* spp. *Ptilidium ciliare*, *Frullania Tamarisci* and several other species often occur in abundance. As examples will best show the composition of this vegetation, the following are given: —

In North-west Iceland heath-vegetation is extensively distributed, especially around Dýrafjördur and Isafjördur. Here the heath-forming plants are mostly *Vaccinium Myrtillus*, *V. uliginosum*, *Empetrum nigrum* and occasionally *Betula nana*.

On heathy ground in Gnupdalur near Dyrafjördur a rather scattered Bryophyte vegetation was found, composed of *Hylocomium proliferum*, *H. parietinum*, *Hypnum uncinatum*, *Dicranum scoparium*, *D. molle*, *D. fuscescens*, *D. Starckei*, *Conostomum boreale*, *Lophozia Flœrckei*, *L. lycopodioides*, *L. Kunzeana*, *L. ventricosa* and



Fig. 25. Grunnavik near Jökulsfjördur in NW. Iceland. Stony slope. The low-lying parts are boggy, the somewhat higher ridges are covered with heath vegetation (*Empetrum*, *Vaccinium*, *Dicranum* spp., etc.), whilst the stony ridges situated highest (in the background) are bare of vegetation.

L. alpestris. The *Dicranum* spp. formed thick, extensive cushions, and the *Lophozia* spp. grew woven into these cushions.

Grunnavik near Jökulsfjördur (Fig. 25). Up to a height of 100—200 metres the mountain slopes were partly covered with heather-moor and partly with bog-vegetation or moss-bogs. The stony ridges, situated higher up, which had been formed by stones sliding down from the mountain above, were covered with heath, while the intervening depressions were boggy, and there along the channels, where the water formed streamlets or issued as springs, the usual "Dy" vegetation consisting of *Mniobryum albicans*, *Philonotis*, etc., had developed.

The Bryophyte carpet of the heath was composed of *Hylocomium parietinum, H. proliferum, Hypnum uncinatum, Rhacomitrium hypnoides, Dicranum scoparium, D. fuscescens, D. molle, Ptilidium ciliare, Lophozia Flœrckei, L. lycopodioides, L. ventricosa, Cephalozia bicuspidata, C. pleniceps* and scattered cushions of *Sphagnum Gir-*



Fig. 26. Knolly moor of *Betula nana* intermixed with *Salix lanata* and *Salix phylicifolia*. Ground vegetation: *Empetrum, Arctostaphylos uva ursi, Anthoxanthum odoratum* and *Polygonum viviparum*.

gensohnii. The *Dicranum* spp. especially *D. scoparium* often formed continuous carpets, which appears to correspond with the "Dicranum heaths" described by C. Jensen, 1910, p. 262.

Knolly Betula nana Heath near Ljosavatn (Fig. 26). In addition to *Betula nana*, which formed the bulk of the vegetation, there occurred scattered shrubs of *Salix phylicifolia, S. glauca* and numerous grasses and flowering plants. Mosses and liverworts grew abundantly on the knolls and on the ground between them. The following species were observed: *Hypnum uncinatum, Rhacomitrium canescens, R. hypnoides* (all in abundance), *Hylocomium proliferum, H. rugosum, H. squarrosum, Camptothecium nitens, Heterocladium squarrosulum, Brachythecium erythrorrhizon, Polytrichum juniperinum, Timmia austriaca, Conostomum boreale, Pohlia cruda, Bartramia ityphylla, Tortella tortuosa, Dicranum congestum, Ditrichum*

flexicaule, *Lophozia lycopodioides*, *L. Kunzeana* and *Plagiochila asplenioides.*

The Moss Heath. On dry stony tracts there often occurs a continuous growth of mosses, in which higher plants grow scattered without being able to give character to the vegetation. In heather-moors mosses often form a continuous carpet, and then all transitions between typical heather-moor and moss-heaths are found. By the decay of the mosses a humus-layer is gradually formed, and the moss-heath is thus the pioneer of other associations such as heather-moors, coppices and grassland (H. Jónsson, 1905, p. 41).

The moss heath occurs most frequently as a *Rhacomitrium*-heath (*Grimmia*-heath, H. J., 1895, p. 70; 1900, pp. 68 and 85; 1905, p. 40). It is found in the low land — where it is typically developed, especially in the lava fields, which are often entirely covered by it — as well as on mountain slopes, and in the Alpine region as far upwards as 600—700 metres above sea-level (Fig. 27). It also occurs in patches in other formations, for instance in grassland, where it is usually developed on the top of the knolls. *Rhacomitrium hypnoides* is the dominant species, and is often the only one found over considerable tracts; it forms a uniformly grey carpet, as much as a foot deep. There is only a very small intermixture of other Bryophyta. The most frequent are *Rhacomitrium canescens*, *Hylocomium proliferum*, *H. parietinum*, *Dicranum scoparium*, *Ptilidium ciliare*, *Frullania Tamarisci*, rarer are *Lophozia lycopodioides*, *L. barbata*, and other species. The *Rhacomitrium* heath is extensively distributed in many places on the taluses of fallen blocks and débris (Urd), and there — in case conditions are favourable — by the mosses decaying and forming humus, it quickly passes into other associations, especially into grass-slopes and herb-slopes.

The *Rhacomitrium canescens* heath is developed on a somewhat damper substratum than is the *R. hypnoides* heath, and is met with, for instance, in patches in depressions in the latter, where it is immediately distinguished by its light greyish-green colour, which differs distinctly from the whitish-grey colour of its surroundings. Here it must frequently share the locality with *Hypnum uncinatum* and is often greatly intermixed with other Bryophyta, for instance *Polytrichum alpinum*, *Hylocomium* spp., *Lophozia lycopodioides* and *L. quinquedentata*, and several other species. As an example of such a *Rhacomitrium canescens* heath may be mentioned a slightly inclined gravelly flat near Holt in South Iceland, about 400 me-

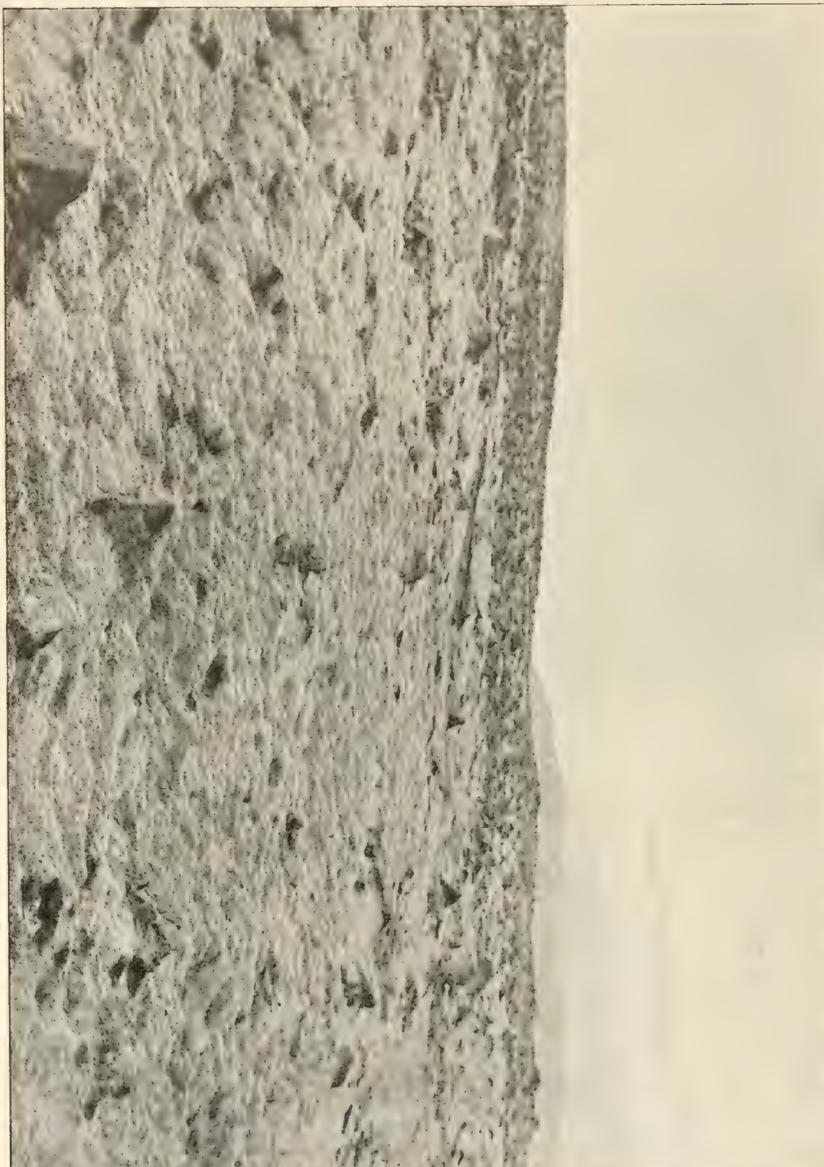


Fig. 27. *Rhacomitrium hypnoides* heath near Mödruvellir (Esja), at an altitude of about 500 metres.

tres above sea-level, which was covered with a continuous carpet of *R. canescens*, in which *Hylocomium parietinum*, *Dicranum Starckei*, *Conostomum boreale*, *Lophozia alpestris* and *L. lycopodioides* occurred scantily interspersed (Fig. 28).



Fig. 28. *Rhacomitrium canescens* heath near Holt in South Iceland. In the background is seen one of the deep clefts with vertical sides, so common in this district.

Near Hof in SE. Iceland there was a horizontal, somewhat damp gravelly flat covered with a continuous moss-carpet, of which the chief species were *Rhacomitrium canescens* and *Hylocomium proliferum*, abundantly mixed with *Hylocomium parietinum*, *H. rugosum*, *H. squarrosum* and *Hypnum uncinatum*. Spread about in the moss carpet there grew *Dicranum scoparium*, *D. congestum*, *Ditrichum flexicaule*, *Tortella tortuosa*, *Polytrichum juniperinum*, *P. alpinum* and *Aulacomnium turgidum*. *Conostomum boreale* was common and occurred in small, compact tufts, usually interwoven with *Lophozia ventricosa*, *Gymnomitrium concinnatum*, *Anthelia* and species of *Cephalozia*, and on prominent knolls of earth *Diphyscium sessile* in association with *Gymnomitrium concinnatum* formed compact blackish-brown coverings. *Aulacomnium turgidum* occurred abundantly in several spots, more or less intermixed with *Hylocomium squarrosum*, *Hypnum uncinatum* and *Rhacomitrium canescens*, and formed carpets. Spread about in the moss carpet grew numerous

Juncus and *Carex* tufts, and this formation must most nearly be termed a transitional form between moss-heath and meadow-land. On the whole, *Rhacomitrium canescens* thrives best in Iceland on somewhat damp ground, under quite similar conditions as *Aulacomnium turgidum*.

The Mixed Moss-heath (*Hylocomium-Rhacomitrium* heath) occurs especially on slightly inclined gravelly flats, under similar conditions as the heather moor, and is, as a rule, a pioneer for the latter. It may, however, also develop into a grass or herb slope, where the ground is wetter. The chief species of this moss carpet are *Rhacomitrium canescens*, *R. hypnoides* and species of *Hylocomium*, but as a rule many other species are found intermixed with these.

In a moss-heath near Mödruvellir (Esja), on a slightly inclined gravelly flat, at an altitude of about 100 metres, the chief species of the Bryophyte carpet were *Hylocomium proliferum*, *Rhacomitrium hypnoides*, *R. canescens* and *Hypnum uncinatum;* more scantily occurred: *Hylocomium loreum*, *H. squarrosum*, *Climacium dendroides*, *Antitrichia curtipendula*, *Brachythecium albicans*, *Polytrichum alpinum*, *P. urnigerum*, *Timmia austriaca*, *Pohlia cruda*, *Ditrichum flexicaule*, *Bartramia ityphylla*, *Distichium montanum*, *Ptilidium ciliare*, *Frullania Tamarisci*, *Lophozia lycopodioides*, *L. quinquedentata* and *L. quadriloba*. Scattered in the Bryophyte carpet grew a few flowering plants such as *Anthoxanthum* and *Galium verum*, and this moss-heath will undoubtedly develop into grassland.

On a flat interspersed with stones at an altitude of about 400 metres the Bryophyte carpet was composed of *Rhacomitrium hypnoides* abundantly mixed with *R. canescens*, *Hylocomium parietinum*, *Hypnum uncinatum* and *Dicranum Starckei*. As an intermixture in the Bryophyte carpet occurred: *Timmia austriaca*, *Pohlia commutata*, *Distichium montanum*, *Lophozia quinquedentata*, *L. quadriloba*, *L. alpestris*, *Plagiochila asplenioides*, *Blepharostoma trichophyllum*, *Anthelia Juratzkana*, *Alicularia scalaris*, *Cephalozia pleniceps* and *C. bicuspidata*. Flowering plants were almost entirely absent.

On prominent knolls of earth occurring on heathland and grassland, on dry ledges and slopes, a very peculiar Bryphyte covering is often found: low, very compact cushions of *Diphyscium sessile* in connection with several liverworts, especially *Gymnomitrium concinnatum*, are found covering the soil with a very dense

brownish-black carpet. *Conostomum boreale* also — usually interwoven with liverworts such as *Gymnomitrium concinnatum*, *Lophozia ventricosa*, *Pleuroclada albescens* and species of *Cephalozia* — forms exceedingly compact cushions on dry, stony ground. Both these species grow in particularly exposed localities, where the snow-covering is absent during winter, but their compact tufts, densely covered with tomentum to an unusual degree, protect them from being destroyed by strong winds. *Diphyscium* forms quite low (only one cm. high), but rather wide tufts, while *Conostomum* forms tufts a few cm. in diameter, but often more than 10 cm. in height. In the latter case the basal portion of the tuft is securely wedged into the gravelly substratum and attached to the stones with numerous rhizoids. *Diphyscium* is found at all levels, while *Conostomum* is most widely distributed on the rocky flats, but in the low land occurs only somewhat scantily in the heath formation.

The Bryophyte Vegetation of the Rocks.

The rock vegetation includes formations of very various composition, with extremely different demands as regards light, moisture, etc. The substratum may consist of solid rock, for instance rock-faces, flats or large blocks, or it may consist of detached stones of various sizes, as on gravelly and stony slopes and on taluses. The distribution of the water is very unequal, since a quite dry part with decidedly xerophilous species may be met with next to a part where the water flows over the rock, and provides conditions for the growth of hygrophilous species.

The chemical and physical nature of the substratum exercises great influence upon the composition of the Bryophyte covering. On tuff and breccia the vegetation is far more luxuriant than on basalt, and the reason for this is partly because the uneven surface of the tuff affords better habitats for the plants, partly because the water penetrates into the tuff comparatively easily, and afterwards reappears through the fissures and porose parts of the rock-surface so that these are, as a rule, rather damp. The greater or smaller amount of lime present is also of importance for the frequency of many species. The direction of the exposure and the conditions pertaining to shelter play a great part with regard to the Bryophyte vegetation. Species growing on exposed rock-faces and flats must be able to endure complete desiccation by the sun during the summer, and by strong winds during the winter, while

the Bryophytes of the clefts and Urds live in a comparatively humid atmosphere and are protected by the snow-covering during the winter. The conditions pertaining to light are also of importance with regard to the composition of the Bryophyte vegetation. On the ground between the stones of the talus, grow other species than those to be found upon the stones. Caves and dark clefts contain species which belong specially to these localities, and the vegetation on vertical surfaces or slopes with a southern exposure is different to that found on the same kind of ground with a northern exposure.

Owing to the extremely different conditions to which plants are exposed when growing on rocks, all kinds of associations are met with there, from decidedly xerophilous to hygrophilous, light-forms, and species which thrive best in dark caves. The rocky substratum may be compared to a mosaic pavement, in which each particular piece of homogeneous conditions is exceedingly small.

The mosses grow partly on the rock itself (lithophytes) and partly in soil which has accumulated in fissures and depressions, or on ledges (chomophytes). The boundary line between these two groups has, however, been effaced to a great extent as many of the lithophytes proper also occasionally grow on gravel or even on soil, and it is not always possible to decide whether a moss-cushion has originally developed on humus-covered rock, or has itself formed humus by a process of decay. Especially on mountain heights the two groups merge one into the other, as species such as *Andreæa petrophila*, *Dicranoweisia crispula*, *Rhacomitrium fasciculare* and *R. sudeticum*, which in low-lying regions are decidedly lithophytes, descend to the ground on mountain heights and often form extensive growths on rocky flats. The following species may be referred to the lithophytes proper (those marked * are common):

Species belonging to Coastal Rocks.

*Ulota phyllantha	*Schistidium maritimum

Water Lithophytes.

*Schistidium rivulare	*Fontinalis longifolia
*Fontinalis antipyretica	*Rhynchostegium rusciforme
— androgyna	*Hypnum ochraceum
thulensis	— alpinum
islandica	— alpestre

The remaining Lithophytes.

*Metzgeria furcata
*Radula complanata
Gymnomitrium coralloides
*Madotheca Cordæana
Frullania fragilifolia
*Andreæa petrophila
*Anœctangium compactum
Weisia crispata
*Dicranoweisia crispula
*Blindia acuta
Bryoxiphium norvegicum
Tortula obtusifolia
— muralis
Schistidium confertum
Grimmia commutata
— alpestris
— Doniana
— ovata
— incurva
patens
— funalis
* — torquata
*Rhacomitrium sudeticum
* — heterostichum
*Rhacomitrium fasciculare
* — aciculare
Hedwigia albicans
*Orthotrichum rupestre
— anomalum
— saxatile
— cupulatum
— Sturmii
— Killiasii
— Blyttii
— lævigatum
Leucodon sciuroides
Neckera complanata
Leskea nervosa
*Pterigynandrum filiforme
Lescuræa patens
Isothecium myurum
— tenuinerve
*Homalothecium sericeum
Thamnium alopecurum
Hypnum Bambergeri
* — revolutum
* — cupressiforme

In addition to the species mentioned above there are a great number of other species which are of equal frequency on bare rocks and on humus-covered rocks. To this group belong for instance *Haplozia atrovirens, Diplophyllum albicans*, *Amphidium Mougeotti*, *Hymenostylium curvirostre*, *Schistidium* spp. and *Hypnum hamulosum.*

To the chomophytes may be reckoned a numerous group of species which partly contain the chomophytes proper, i. e. species which properly speaking belong to humus-covered rock-ledges or to clefts, and partly a great number of species which are as frequently met with in other formations. The following species may be regarded as belonging to the chomophytes proper: —

Reboulia hemisphærica
Sauteria alpina
Fimbriaria pilosa
Fegatella conica
Preissia commutata
Haplozia riparia
* — atrovirens
*Haplozia pumila
Lophozia heterocolpos
Tortula mucronifolia
*Encalypta rhabdocarpa
* — ciliata
*Amphidium lapponicum
Hymenostylium curvirostre

Sælania cæsia
Anomobryum filiforme
*Plagiobryum Zierii
Bryum æneum
— pallescens
capillare
*Mnium orthorrhynchum
— serratum
— stellare
*Orthothecium chryseum
— intricatum
Eurhynchium strigosum
— Swartzii
*Plagiothecium pulchellum
— depressum
— Rœseanum
*Amblystegium Sprucei
Hypnum hamulosum

Among the species met with here, which however cannot be reckoned to the chomophytes proper, the following are the most frequent: *Bartramia ityphylla, Pohlia cruda, Bryum inclinatum, B. ventricosum, Oncophorus virens, O. Wahlenbergii, Didymodon rubellus, Distichium montanum, Schistidium apocarpum, S. gracile, Ditrichum flexicaule, Philonotis tomentella, Marchantia polymorpha, Lophozia* spp., *Scapania curta, S. subalpina* and *Blepharostoma trichophyllum.*

Stony and Gravelly Slopes. The Bryophyte vegetation is, as a rule, rather poor in species, and not very characteristic. *Rhacomitrium* heaths are common where the slope is not too steep, but stony and gravelly slopes are often almost bare of vegetation, only here and there occur some cushions of *Dicranoweisia crispula* and species of *Rhacomitrium.*

A Stony Slope near Grunnavik in NW. Iceland consisted of large blocks at the foot, and in the upper and steeper part of smaller stones. Vegetation was absent at the top, but increased in abundance lower down as the ground gradually become more level, and the conditions thereby became more stable. Scattered among the stones grew plants of the rocky flat, for instance *Salix herbacea, Papaver radicatum, Oxyria digyna, Sibbaldia procumbens* and in the shelter afforded by larger stones *Athyrium alpestre, Alchemilla alpina,* etc. Upon the stones grew *Rhacomitrium hypnoides, R. fasciculare* and *Dicranoweisia crispula* and on the ground between the stones *Brachythecium reflexum, Hypnum uncinatum, Lescuræa patens, L. filamentosa, Hylocomium squarrosum, Polytrichum alpinum, Dicranum fuscescens, Lophozia ventricosa, L. lycopodioides* and *Anthelia julacea.*

Stony Slope near Berufjördur. On the steep somewhat damp slope there grew *Rhacomitrium fasciculare, Schistidium gracile, Dicranoweisia crispula, Lescuræa decipiens, Heterocladium squarrosulum* and *Timmia austriaca.*

Talus of fallen blocks and débris (Urd). The conditions for the development of plants is far more favourable here than on the stony slope, which is constantly exposed to disturbances through the down-sliding of stones and earth. The most xerophilous species, viz. species of *Rhacomitrium* and *Grimmia*, *Dicranoweisia crispula*, *Orthotrichum rupestre* and *Hypnum revolutum* grow on the stones, while on the ground between the stones there are favourable conditions for a number of species which have greater requirements with regard to shelter, moisture and shade. The Urd is therefore very rich in species, since lithophilous species are found there on the blocks, and species, which grow on the ground, occur between the stones, and Bryophytes belonging to heathland and grassland, are found on the soil-covered stones and ledges.

In order to show how heterogeneous the composition of the Bryophyte vegetation may be, the Urd in Heljusdalur on Vestmannaey may serve as an example. The valley is almost semicircular in shape, and open towards the south, and in consequence of this favourable situation combined with the comparatively mild, damp climate of the island, a considerable number of southern species are found there, while species such as *Ulota maritima* and *Schistidium maritimum* betoken the proximity of the sea. The rocks around the valley are inhabited by numerous sea-fowls, and they often rest on the blocks of the Urd, and on these spots, manured by the birds, it is species of *Bryum* (*B. argenteum* and *B. capillare*) which particularly make their appearance.

The fallen blocks are everywhere covered with cushions of mosses and liverworts. The commonest species are *Schistidium apocarpum*, *Ulota maritima*, *Hypnum cupressiforme*, *H. uncinatum*, *Orthotrichum rupestre* and *Ceratodon purpureus*. The following species were also observed on the blocks: *Radula complanata*, *Madotheca Cordæana*, *Plagiochila asplenioides*, *Cephaloziella Hampeana*, *Didymodon rubellus*, **Barbula cylindrica*, *Tortella tortuosa*, *T. fragilis*, *Tortula subulata*, **T. mucronifolia*, *Distichium montanum*, **Orthotrichum anomalum*, *Encalypta ciliata*, *E. rhabdocarpa*, *Pohlia cruda*, *Bryum capillare*, *B. elegans*, *B. inclinatum*, *B. æneum*, *Mnium serratum*, *M. stellare*, *M. orthorrhynchum*, *Myurella julacea*, *Orthothecium intricatum*, **Isothecium myurum*, *Homalothecium sericeum*, *Amblystegium Sprucei*, **A. serpens*, *Hypnum hamulosum* and *H. revolutum*. In the caves formed among the stones, into which the light penetrated but scantily, the walls were covered with light-green shining mats

of **Plagiothecium depressum*, the ground between the blocks was covered with a thick, dark-green carpet of *Hypnum uncinatum, Hylocomium squarrosum, Brachythecium salebrosum*, **Eurhynchium Stockesii, Plagiothecium Roeseanum*, **Thuidium tamariscinum, T. abietinum*, **Mnium undulatum, Ditrichum flexicaule, Dichodontium pellucidum*, **Lophocolea cuspidata*, **L. minor* and *Lophozia quinquedentata*. On the soil-covered grassy ledges and slopes, between the stones, grew *Brachythecium albicans, B. salebrosum* (in masses), *Climacium dendroides* (in abundance), *Camptothecium lutescens, Hylocomium proliferum, H. parietinum* (sparingly) and *Mnium affine* (in abundance).

All the species marked * are southern forms the majority of which have only been found in South Iceland. On the whole, the Urd affords favourable habitats for many species which do not thrive in more exposed localities.

On a dry Urd consisting of large blocks of basalt, near Holt, in South Iceland, the following species were growing: — *Rhacomitrium fasciculare, R. heterostichum, R. hypnoides, Grimmia Doniana, Schistidium apocarpum, Andreæa petrophila, Antitrichia curtipendula, Hypnum uncinatum, Hylocomium loreum, H. proliferum, H. parietinum* and *Frullania Tamarisci*.

Almost the same species are found on larger detached blocks. On blocks of lava round about Reykjavik there grew particularly *Rhacomitrium heterostichum, R. fasciculare, Andreæa petrophila, Schistidium apocarpum, Grimmia Doniana* and *Dicranoweisia crispula*.

On larger stones in the home-field (Tunet) near Vallanes (East Iceland) there grew *Pterigynandrum filiforme, Hypnum revolutum, Tortula ruralis* and *Encalypta rhabdocarpa*. Some large blocks near Hafursholt in South Iceland were quite overgrown with *Grimmia alpestris*. On some large blocks of basalt near Seljaland there grew *Grimmia Doniana, Rhacomitrium fasciculare, R. hypnoides, R. sudeticum, Dicranoweisia crispula* and *Gymnomitrium coralloides*.

The Vertical Rock-belts. Owing to the division into layers peculiar to the basalt, the mountain sides consist of numerous vertical scarps of varying height, alternating with slopes formed by fallen blocks and debris. As a rule, the first 100—200 metres of the mountain form a slope which is only slightly inclined at the bottom and becomes steeper higher up, and where only here and there small portions of the primitive rock protrude. This slope is limited by a precipitous rock-face of very varying height, sometimes ris-

ing to a height of several hundred metres, right up to the plateau on the mountain top, but usually divided into numerous steps, consisting of shelves or ledges of varying breadth. The rock-face is here and there intersected by deep fissures and clefts, excavated by the downward-flowing water, which partly drains away in



Fig. 29. Face of basalt rock (E. Iceland). Everywhere in the crevices small, black, moss-cushions (*Andreæa, Dicranoweisia crispula* and *Grimmia* spp.).

these channels, partly spreads over the ledges and from thence flows down the rock-faces or penetrates into the crevices of the rock, and then reappears once more further down. Consequently, the conditions pertaining to moisture vary greatly, and therefore the moss-covering also. As some examples will best show the composition of the latter, the following are given: —

1. Esja, low damp rock-face just above the slope:

Philonotis tomentella, Mnium punctatum, M. orthorrhynchum, Amphidium Mougeottii, A. lapponicum, Anœctangium compactum, Didymodon rubellus and *Schistidium gracile* grew abundantly in extensive cushions. *Lescuræa filamentosa* was found abundantly at the basal part of the rock-face. *Pohlia cruda, Bartramia ityphylla, Plagiothecium pulchellum, Myurella julacea, M. tenerrima, Radula complanata, Haplozia atrovirens* and *Marchantia polymorpha* grew partly in small tufts, partly intermixed with other species in the tufts formed by them.

2. Botnsdalur, Hvalfjördur: damp rock-face. The base of the rock-face, up to a height of about a few metres, was covered with extensive cushions of *Hypnum cupressiforme, H. molluscum, Brachythecium glareosum, Orthothecium chryseum, Philonotis tomentella* and *Distichium montanum.* Where the rock-face was wet with the downward-oozing water, large patches of it were covered with *Anomobryum concinnum.* Partly in the crevices of the rock-face, partly scattered in the tufts there occurred *Amblystegium Sprucei, Bryum pallescens, B. inclinatum, Lophozia quinquedentata, L. Mülleri, Blepharostoma trichophyllum* and *Aneura pinguis.*

3. Berufjördur, rock-face, where the water was oozing down from the ledge above: *Hypnum alpestre, Orthothecium chryseum, Blindia acuta, Onchophorus Wahlenbergii, Plagiopus Œderi, Philonotis fontana, Distichium montanum, Myurella julacea, M. tenerrima, Scapania subalpina, Lophozia quinquedentata, Haplozia atrovirens* and *H. cordifolia.*

4. Seydisfjördur, dry rock face with a northern exposure. On the dry rock face itself there grew: *Pterigynandrum filiforme, Homalothecium sericeum, Grimmia funalis, G. torquata, Hypnum revolutum* and *Orthotrichum rupestre.* The basal part of the rock-face was much weathered, presenting numerous crevices and small ledges. There grew: *Hypnum revolutum, H. filicinum, Orthothecium chryseum, Plagiothecium pulchellum, P. Roeseanum, Myurella julacea, M. tenerrima, Amphidium Mougeottii, Mnium orthorrhynchum, Bartramia ityphylla, Pohlia cruda, Plagiobryum Zierii, Meesea trichoides, Orthotrichum Blyttii, Distichium montanum, Ditrichum flexicaule, Fissidens osmundoides, Schistidium confertum, Didymodon rubellus, Metzgeria furcata, Blepharostoma trichophyllum* and *Odontoschisma elongatum.*

5. Akureyri, dry rock-face, 350 metres above sea-level. The rock-face was covered with extensive mats of *Homalothecium sericeum* and *Pterigynandrum filiforme* mixed with cus-

hions of *Grimmia funalis*, *Hypnum revolutum*, *Rhacomitrium heterostichum* and *Orthotrichum rupestre.* On the basal and somewhat damper portion of the rock-face there grew *Gymnostomum rupestre, Philonotis tomentella, Orthothecium chryseum, Hypnum uncinatum, Distichium montanum, Ditrichum flexicaule, Amphidium lapponicum, Pohlia cruda, Bartramia ityphylla, Ceratodon purpureus, Tortella tor-*

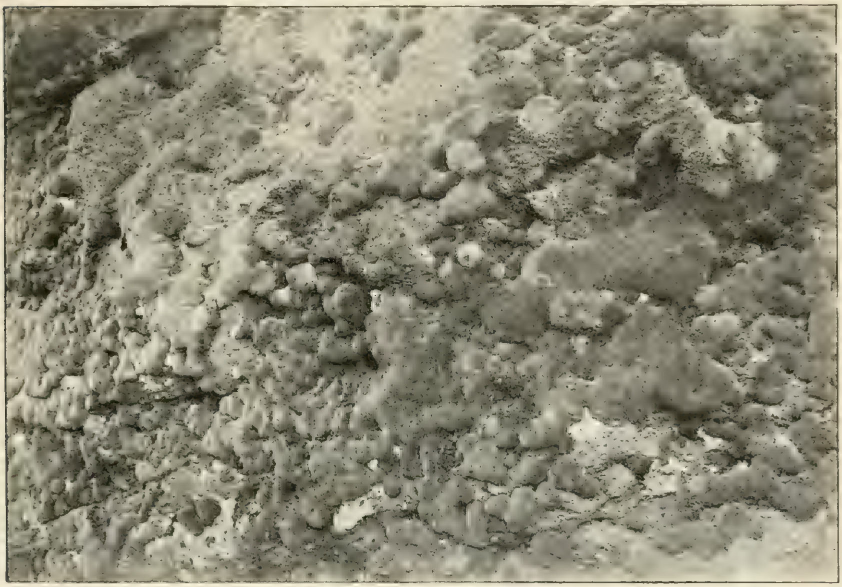


Fig. 30. *Grimmia torquata* on one of the sides of Flokastadagil.

tuosa, *Lophozia quinquedentata, L. quadriloba* and everywhere on the ledges large cushions of fruiting *Tortula ruralis.*

The two last quoted examples are typical of the vegetation of dry rock-faces. *Homalothecium sericeum* occurs there almost always, and is often dominant on exposed rock-faces as far upwards as 400—500 metres above sea-level, *Pterigynandrum* is also extremely common, especially in the low land. *Grimmia funalis* is rarely absent and often forms very large and deep, fruiting tufts, and especially in South Iceland *G. torquata* is extremely common and often covers large portions of the rock-faces with its irregularly-rounded cushions (Fig. 30).

6. Low, much weathered and fissured basalt rocks near Hof in SE. Iceland. On the top of the rocks it was espe-

cially *Rhacomitrium hypnoides* which grew abundantly on débris produced by disintegration. On the rocks there grew *Hypnum cupressiforme, H. revolutum, H. imponens, Pterigynandrum filiforme, Leskea nervosa, Rhacomitrium fasciculare, R. heterostichum, Grimmia funalis, G. Doniana, Schistidium apocarpum, S. confertum, Dicranoweisia crispula, Andreæa petrophila, Orthotrichum rupestre, O. Sturmii, Gymnomitrium coralloides, Frullania Tamarisci, Radula complanata, Metzgeria furcata* and at the base of the rock, *Madotheca Cordæana.* A southern rock-face was covered with *Leucodon sciuroides* var. *morensis.* In clefts and crevices and on soil-covered ledges there grew *Mnium orthorrhynchum, M stellare, Pohlia cruda, Encalypta ciliata, E. rhabdocarpa, Bartramia ityphylla, Dicranum Andersonii, Distichium montanum, Ditrichum flexicaule, Didymodon rubellus, Amphidium lapponicum, Plagiochila asplenioides, Marsupella Funckii* and *Lophozia alpestris.*

The locality just described comes nearest to that known in Iceland as "Holt", *i. e.* low, stony ridges or protruding masses of rock in the low land. The vegetation upon these "Holts" is generally xerophilous in character and is, as a rule, not so rich in species as is the vegetation mentioned above. The ridges are usually more or less covered with soil which bears heath-vegetation, or are occupied by gravelly flats, therefore the Bryophyte vegetation consists chiefly of species belonging to heathland or grassland (*Hylocomium* spp., *Polytrichum alpinum, P. juniperinum, P. pilosum, Hypnum uncinatum, Frullania Tamarisci, Rhacomitrium* spp., etc.), while directly upon the rocks there grow species such as *Hypnum cupressiforme, H. hamulosum, H. revolutum, Orthotrichum* and *Grimmia* spp., and in the crevices *Bartramia, Pohlia cruda, Amphidium lapponicum, Mnium orthorrhynchum, Myurella, Distichium montanum* and other of the species found in rock-clefts in greater or smaller quantities.

The Bryophyte Vegetation of the Tuff Rocks.

The reason why the Bryophyte vegetation of the tuff rocks is here treated in a separate section is that the life-conditions of the plants are essentially different on a basalt and on a tuff substratum. Tuff consists of consolidated fine-grained material (volcanic ash and dust) through which are scattered larger and smaller blocks of rock. While the basalt has a smooth surface, with fissures and depressions only here and there, the surface of the tuff is uneven and

rough, and therefore offers more favourable conditions to the mosses for attaching themselves to it. When a basalt and a tuff surface occur side by side, as is often the case, the difference is very obvious. Mosses grow more scantily on basalt, since it is distinctly seen that the majority of the tufts are situated in, or proceed from,



Fig. 31. Tuff cleft (Bleikságil) near Barkarstadr.

a fissure, while tuff surfaces are often covered with a continuous moss-carpet, composed of many different species. It is also a fact of great importance that the water which flows down from above, and atmospheric humidity, are available to the mosses of basalt surfaces only as long as the water is flowing or is deposited, while the tuff is able to absorb water through its porose surface, and thus has a constant supply of necessary moisture for the vegetation. Owing to the slight power of resistance of the tuff against the ero-



Fig. 32. Side of tuff-cleft near Barkarstadr. At the foot of the cleft, among others *Mnium undulatum* grew abundantly. On the sides there grew *Hypnum filicinum* (at the top, to the right), *Fegatella conica* (in the middle and to the left), *Philonotis fontana*, *Mniobryum albicans* and many other mosses.

sive action of water, many more clefts and caves with damp surfaces are met with here than on the basalt, and these provide ideal habitats for a great number of mosses.

Tuff deposits of volcanic origin are found in many places in

Iceland, but the reason why in the following only the Bryophyte vegetation of South Iceland is mentioned, is because it is only this part of Iceland that has been somewhat thoroughly investigated.

Fljótshlid. North of the great river Markarfljót, the country rises to a height of 200—600 metres. The slope stretching downwards to the Markarfljót is trenched by a great number of smaller streams, many of which flow at the bottom of deep, narrow clefts in the tuff-layers.

One of the longest and deepest clefts is Bleikságil near Barkarstadr (Fig. 31). This cleft has almost everywhere vertical or overhanging sides, 100 or more metres in height, and is so narrow at the top that in some places goats can jump across it. It is therefore quite inaccessible for the greater part of its length, hence only its lower part has been investigated. The sides were there usually covered with enormous mats of mosses of which the principal species were *Hypnum falcatum*, *H. filicinum*, *H. molluscum*. *Brachythecium rivulare* and *Philonotis fontana*, all of which were developed to an unusually luxuriant degree. *H. falcatum* and *H. filicinum* were in many places thickly covered with ripe capsules.

In this moss carpet a great number of other Bryophyta were found, partly intermixed with each other, partly in larger or smaller tufts or growths. The following species were observed: *Philonotis tomentella*, *Bryum æneum*, *B. pallens*, *B. ventricosum*, *B. inclinatum*, *Mniobryum albicans*, *Mnium serratum*, *M. punctatum*, *Anomobryum filiforme*, *Encalypta ciliata*, *Didymodon rubellus*, *Barbula cylindrica*, *Distichium montanum*, *Hymenostylium curvirostre*, *Anœctangium compactum*, *Amphidium Mougeottii*, *A. lapponicum*, *Haplozia riparia*. *H. cordifolia*, *Lophozia quinquedentata*, *L. Mülleri*, *Scapania irrigua*, *Blephorostoma trichophyllum*, *Madotheca Cordæana*, *Radula complanata*, *Metzgeria furcata* and *Marchantia polymorpha*. At the base of the rock-side grew, among others, *Mnium undulatum* and *Thuidium tamariscinum*. At the extreme end of the cleft, where the sun could shine on the rock faces, fruiting specimens of *Preissia commutata* often grew in abundance. The walls in the numerous caves were often covered with *Eurhynchium Swartzii* and *Fegatella conica*. in company with many, or a few, of the species found on the sides of the cleft, which, however, on the whole, did not thrive well in the scanty light. In many places *Fegatella* formed also a belt along the basal part of the rock-sides, especially where they projected. On the roof of the caves *Blepharostoma trichophyllum* and *Ambly-*

stegium Sprucei formed thin, dark-green coverings, and where the water flowed down the roof and walls *Thamnium alopecurum* occurred as pure growths.

A similar vegetation was found everywhere in clefts and caves, and where the conditions pertaining to light and moisture were more varying, the number of the species was still greater than in the vegetation described above. This was for instance the case in the deep and broad Flokastadagil near Breidabolstadr. There, on the damp walls, almost the same species were growing as in

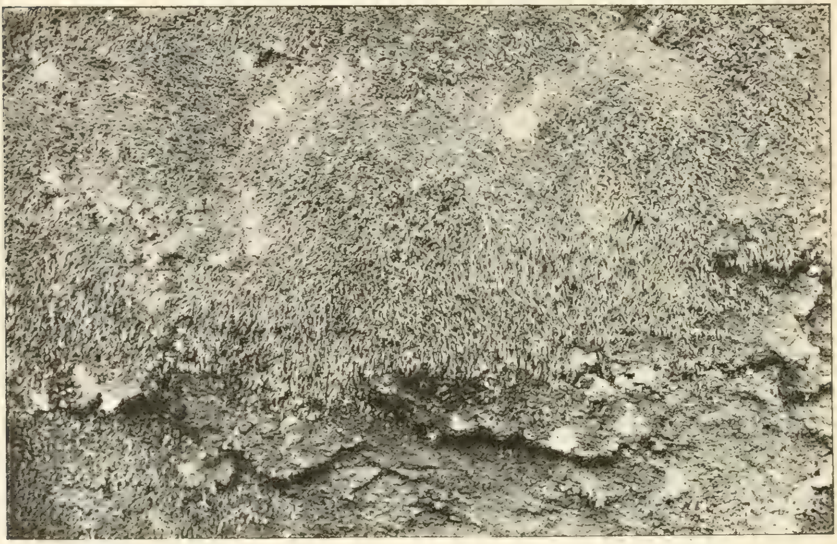


Fig. 33. *Bryoxiphium norvegicum* on one of the sides of Flokastadagil.

Bleikságil. A high, dry, perpendicular rock-face was for a considerable distance entirely covered with a shining, dark-green mat of *Bryoxiphium norvegicum* (Fig. 33), which has hardly been found elsewhere in such enormous quantities. In other places *Grimmia torquata* covered the rock-sides and blocks with its irregularly-rounded cushions, and *Hypnum palustre* was very common everywhere at the water's edge. *Neckera complanata* was common in dry ditches.

At the side of a small waterfall, Klitnafoss, there was a rather large cave, down one side of which some of the water from the waterfall was running. There *Thamnium alopecurum* grew abundantly, while the drier walls of the cave were covered with *Eurhynchium Swartzii* and *Mnium orthorrhynchum*. On the ground at the

bottom of the cave there grew *Timmia austriaca*, *Bryum ventricosum*, *Brachythecium rivulare*, *Thuidium delicatulum* and *Marchantia polymorpha*, and at the entrance to the cave where the water was dripping down, *Mnium undulatum* occurred. The upper part of the walls and the roof were covered with *Blepharostoma trichophyllum*, *Amblystegium Sprucei*, *Metzgeria furcata* and *Radula complanata*, and in the better-lighted part around the entrance, the cave was covered with *Homalothecium sericeum* and *Orthothecium intricatum*.

The Southern Slope of Eyjafjall consists partly of basalt and partly of tuff-layers. The numerous rivers which issue from the Jökull usually flow at the bottom of deep, narrow clefts in the tuff-layers.

Holtsá, which is a glacier-river of rather considerable size, flows for almost its entire course, from the Jökull down to the low land, at the bottom of deep clefts which are accessible only in a few places, the water usually rising from the bottom up to the perpendicular rock-wall. The sides are, as a rule, rather damp, and the water from the slopes above often flows down the rock-faces. The Bryophyte vegetation is extremely luxuriant, and the sides of the clefts are, for considerable distances, covered with enormous carpets of mosses and liverworts. The following species covered the fallen blocks and débris at the base of the cleft-sides: *Hylocomium* spp. (especially *H. squarrosum* and *H. proliferum*), *Hypnum stellatum*, *Acrocladium cuspidatum*, *Climacium dendroides*, *Eurhynchium Stockesii*, *Thuidium tamariscinum*, *Mnium undulatum*, *M. punctatum*, *Timmia austriaca*, *Marchantia polymorpha*, etc. In the numerous open caves and under overhanging rocks, a characteristic vegetation of *Marchantiaceæ* was found. *Preissia commutata* (fr.) and *Fegatella conica* covered the sides with metre-broad mats, and *Reboulia hemisphærica* occurred abundantly in several places, and was also fruiting. Here *Eurhynchium Swartzii* also was at home, especially on the less damp rock-faces, while *Thamnium alopecurum* preferred spots where the water was flowing down. Where streamlets were running from above down the rock-sides, there grew *Rhynchostegium rusciforme*, *Brachythecium rivulare*, *Haplozia cordifolia* and, lowermost, *Thamnium*, while the more or less damp rock-faces were covered with a variegated carpet of mosses and liverworts, unusually rich in species and composed of *Hypnum filicinum* (in masses), *H. falcatum* (in masses), *H. molluscum* (in masses), *Philonotis tomentella*, *P. fontana* (in abundance), *Mnium serratum*, *M. stel-*

lare, M. orthorrhynchum, Bryum æneum, B. inclinatum, B. pallescens, B. ventricosum, Mniobryum albicans (common), *Pohlia cruda, Plagiobryum Zierii, Anomobryum filiforme* (in one place in fr.), *Amphidium Mougeottii, A. lapponicum, Anœctangium compactum, Hymenostylium curvirostre, Blindia acuta, Ditrichum flexicaule, Distichium montanum, Barbula cylindrica, Didymodon rubellus, Tortella tortuosa, T. fragilis, Grimmia apocarpa, Myurella julacea, Haplozia riparia, H. atrovireus, Madotheca Cordæana, Lejeunea serpyllifolia, Radula complanata, Metzgeria furcata, Chiloscyphus polyanthus, Lophocolea cuspidata* (scanty), *Scapania irrigua, Lophozia quinquedentata, L. Mülleri* and *Aneura pinguis.* The moss-carpet covering dry rock-faces and large blocks was chiefly composed of *Hylocomium loreum* (also in fr.), *H. proliferum, Hypnum uncinatum, H. hamulosum* and *H. callichroum.* In a dry cave above the cleft there grew *Neckera complanata, Brachythecium populeum, B. velutinum, Plagiothecium denticulatum, P. depressum, Isothecium tenuinerve, Mnium cuspidatum,* and on the roof of the cave there grew *Amblystegium Sprucei* and *Blepharostoma.*

The southern side of Drángshlidarfjall and the small neighbouring group of mountains, Hrútafjall (Fig. 34), consist, in a great measure, of dry, lofty faces of tuff-rock, as much as 200 metres high, the base of which is moss-grown. One of the commonest species here is *Leucodon sciuroides* var. *morensis* which covered the rock-face for a considerable distance upwards with its extensive and often richly-fruiting mats. The following species were also common: *Homalothecium sericeum, Pterigynandrum filiforme, Hypnum revolutum* and *Grimmia torquata.* At the foot of the rock-faces there grew *Isothecium myurum* (in abundance), *Orthotrichum rupestre, Didymodon rubellus, Barbula cylindrica, Bryum capillare, Tortella tortuosa, Encalypta ciliata, Neckera complanata, Myurella julacea* and *Metzgeria furcata,* and where the water was oozing through cracks and crevices the rock-face was covered with *Blindia acuta* intermixed with *Hypnum molluscum, H. palustre* and the rare *Anomobryum concinnatum.*

Among the large blocks of tuff on a small Urd there grew, among others, *Mnium undulatum, Eurhynchium piliferum, Rhynchostegium murale* (abundantly), *Amblystegium Juratzkanum, Leskea nervosa* and *Lejeunea cavifolia.*

The walls in the interior of a rather dry, open cave, were covered with *Preissia commutata, Fegatella conica, Marchantia polymorpha, Distichium montanum, Bryoxiphium norvegicum, Anœctangium*

compactum (all in abundance), *Reboulia hemisphærica*, *Mnium orthorrhynchum*, *Funaria hygrometrica*, *Bryum æneum*, *B. inclinatum*, *Orthothecium intricatum*, *Blepharostoma trichophyllum* and, where it was somewhat damper, with *Eurhynchium Swartzii*.



Fig. 34. Hrútafell south of Eyjafjallajökull. The perpendicular face of tuff-rock in the centre, is about 200 metres high, and, at the foot is covered with extensive moss carpets, whilst caves occur in many places.

A very interesting kind of vegetation was found on the dry faces of a small isolated rock, Drángshellir. There grew *Leucodon sciuroides* var. *morensis*, *Homalothecium sericeum*, *Leskea nervosa*, *Grimmia Doniana*, *Barbula muralis*, *B. obtusifolia*, *Orthotrichum anomalum* and *O. rupestre*. Half of these species consist of xerophilous southern forms, which have their northern limit in South Iceland, and are there met with only in specially protected localities. Drángshlid, which has a height of 478 metres, protects this locality

from the cold, north winds, without, however, preventing the sun from warming the tuff-faces.

The Bryophyte Vegetation of the Lava-fields.

A very great part of Iceland is covered with lava. According to Thoroddsen (1914, p. 219) the post-glacial lava-fields of Iceland cover an area of about 11,200 square km. or almost $^1/_9$ of the entire area of the island. It is, however, only a very small part of this vast area which has been an object of bryological investigation. Grönlund (1874, p. 136 and 1890) was the first to mention the vegetation of the lava-fields, in his description of the *Rhacomitrium* heath as important for the further development of the plant covering. Ostenfeld (1898, p. 246) has given a description of the lava-fields of the peninsula of Reykjanes without, however, entering more closely into the subject of the Bryophyte vegetation. Helgi Jónsson (1900, p. 89) has given a very detailed account of the vegetation of Búdahraun and Eldhraun in West Iceland, also with regard to the Bryophyta, and the same author, in his description of the vegetation of South Iceland, mentions the Bryophyte vegetation of several lava-fields, especially modern ones. Lastly, A. Wegener in 1912 made a few collections on the high-lying Odádahraun (600—1200 metres above sea-level).

Besides a small part of Mývatnshraun, around the farm Reykjahlid, which was very superficially investigated owing to the inclemency of the weather, my own investigations include only the lava-fields of SW. Iceland, especially Hafnarfjardarrhraun, Thingvallahraun and Svinahraun around Kolvidarhol.

The lava-field is no single formation, but, on the contrary, includes a great number of different formations, ranging from the dry rock-flats and the *Rhacomitrium* heath, through the heather moor and grassland to the bog formations in the deepest hollows, and the associations of damp rocks in clefts. When it is nevertheless described here in a separate section, as by Helgi Jónsson, the reason is that the vegetation of the lava-fields of the lowlands everywhere presents so many common features and peculiarities that we may be justified in describing the Bryophyte vegetation occurring there.

According to the nature of the surface, the lava-fields may be classified into two groups, viz. block-lava (Icelandic *Apalhraun*) and sheet-lava (Icelandic *Helluhraun*). The former consists of blocks of

lava thrown together into irregular heaps, while sheet-lava consists of large, irregularly broken surfaces, which are formed by a process of slow solidification, and are furrowed by innumerable clefts and fissures, both narrow and broad. Here vesicular hollows are also found, produced by the moisture of the substratum which has formed large steam-vesicles in the molten lava, and after solidification the



Fig. 35. Lava-field in the district of Borgarfjördur. The lava is covered to a depth of one foot with a layer of *Rhacomitrium hypnoides*. Projecting parts of the lava are covered with crustaceous lichens. Here and there a tuft of *Festuca ovina*. Birch coppice in the background.

roof of the vesicle has collapsed, and has formed a platform on the floor of the cavity. Such vesicles in the lava — which are characterized by very luxuriant vegetation, since they afford excellent shelter for the plants, and are inaccessible to sheep — may differ rather greatly in depth, according to the thickness of the lava-sheet. In Budahraun, according to Jónsson, their depth averages from 2—6 metres, but is usually somewhat above 2 metres, and in Hafnarfjardarrhraun the depth was also usually some 2 metres. The lava-fields are often furrowed by deep clefts or cracks, frequently of considerable length and with perpendicular sides. This is, for instance, the case in Thingvallahraun where the best-known cleft, Almannagjá, has a length of almost 15 kilometres.

The surface of the lava-field is very dry, because the water can easily drain away through the cracks, therefore, the vegetation there is decidedly xerophilous. As a rule, the *Rhacomitrium* heath *(R. hypnoides)* — in which other Bryophyta, such as *Dicranum scoparium*, *Hylocomium proliferum* and *Ptilidium ciliare*, occur only extremely scantily — covers the greater part of the lava-fields, and there arrives at its fullest development, so that extensive areas may be found covered with foot-deep, soft, greyish carpets which hide all irregularities of the surface. The importance of the moss-covering for the further development of the plant-covering, partly by binding the drifting sand, partly by forming soil, has been demonstrated by Grönlund and Helgi Jónsson.

The chief reason for the extensive distribution of the moss-heath must undoubtedly be sought in the nature of the surface. This is, as a rule, highly vesicular, and contains numerous small holes and cavities, in which the plants find good conditions for taking root. Therefore, many of these cavities are filled up with small moss-cushions (Fig. 36), which, from thence, extend over the rock-surfaces and gradually merge into one another (Helgi Jónsson, 1900, p. 83).

The tops of the lava-cones and the protruding blocks are not covered with a continuous moss-carpet, but usually with scattered cushions of mosses, liverworts and lichens. The most frequent species there are *Rhacomitrium heterostichum*, *R. fasciculare*, *Grimmia apocarpa*, *G. funalis*, *Andreæa petrophila*, *Hypnum revolutum*, *Homalothecium sericeum*, *Pterigynandrum filiforme*, *Dicranoweisia crispula*, and occasionally *Gymnomitrium coralloides*, *G. concinnatum*, *Dicranum fulvellum*, *Rhacomitrium sudeticum*, *Polytrichum pilosum*, besides which there are several other species. Thus, near Hafnarfjördur (and partly also in Búdahraun), in addition to the majority of the species mentioned above, there occurred *Orthotrichum rupestre*, *O. Sturmii*, *Grimmia patens*, *Leucodon sciuroides* var. *morensis*, *Isothecium tenuinerve* and *Frullania Tamarisci*. Near Thingvellir, where the surface of the lava is very dry, there grew upon the lava-cones many crustaceous lichens, *Rhacomitrium fasciculare* (in abundance), *Grimmia apocarpa*, *Andreæa petrophila*, *Polytrichum pilosum* and, here and there, some *Gymnomitrium coralloides* and *Dicranum fulvellum*; and, where some soil had accumulated, *Ceratodon purpureus* and *Pohlia nutans* grew scantily. In the depressions *Rhacomitrium hypnoides* was gradually replaced by *R. canescens*, heather moor and grassland, and in the deepest depressions small patches of bog and

swamp vegetation may occur. The *Rhacomitrium* heaths are gradually transformed into heather moors and birch coppices through the decaying of the mosses and their forming humus. But all these

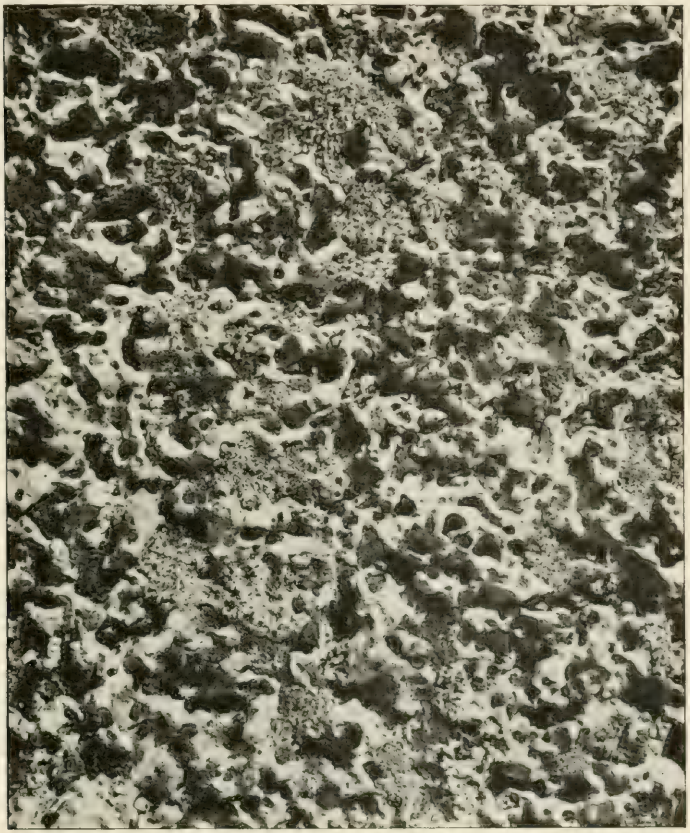


Fig. 36. The surface of a lava block with small moss-cushions (*Andreæa*, *Grimmia* spp. and *Gymnomitrium coralloides*).

formations will not be treated of more fully here as the mosses occurring in them have been mentioned in previous sections. Very extensively distributed and very characteristic is the *Rhacomitrium-canescens* formation which often replaces *R. hypnoides* in flat depressions where the ground is somewhat damp, and where some sand has accumulated. It is often abundantly mixed with other Bryophyta such as *Hylocomium* spp., *Hypnum uncinatum*, *Dicranum scoparium*, *Polytrichum alpinum* and species of *Lophozia*.

Lava-clefts. The caves, clefts and cavities which occur everywhere in the lava-fields contain a Bryophyte vegetation very rich in species. In the broader clefts and in the lava-vesicles (Helgi Jónsson's "Herb-cavities", 1900, p. 90) the bottom is often covered



Fig. 37. Lava-cleft near Thingvellir (Almannagjá). The lava-blocks are quite covered with *Rhacomitrium hypnoides.*

with ferns and flowering plants, and especially in deeper clefts, or where the bottom is covered with loose blocks, there is also found a continuous carpet of mosses and liverworts in which *Hylocomium* spp. *(H. proliferum, H. parietinum, H. loreum, H. squarrosum* and *H. triquetrum)* together with species of *Rhacomitrium, Hypnum* and *Dicranum* play a prominent part, and are usually much interwoven with liverworts such as *Lophozia lycopodioides, L. quinquedentata, L. Kunzeana, Cephalozia* spp., *Alicularia scalaris, Ptilidium ciliare*, etc.

Very frequently a large form of *Hypnum callichroum*, with regularly two-rowed ramification, is the most abundant constituent of the vegetation, especially in somewhat damp and shady clefts. *Eurhynchium piliferum* is often met with very abundantly, especially where

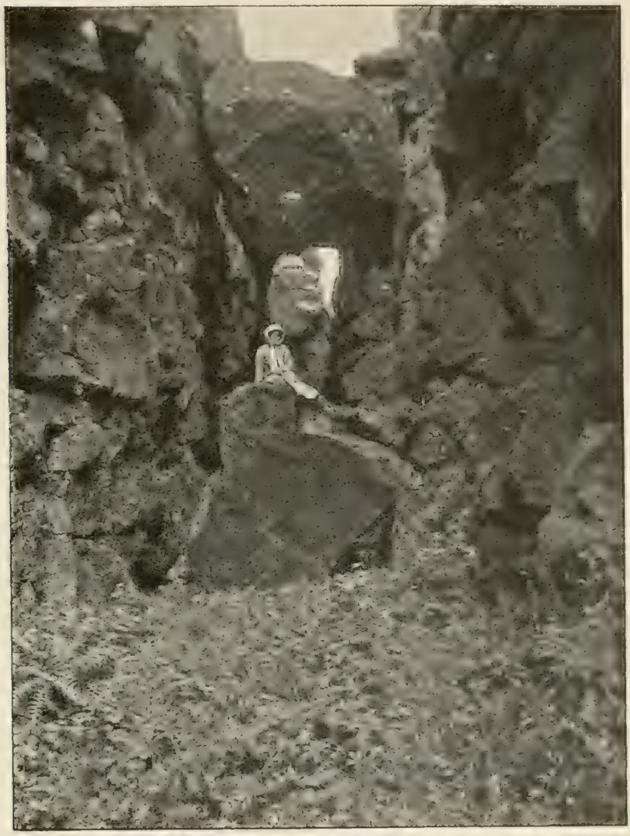


Fig. 38. Lava-cleft near Thingvellir. At the bottom there is a very luxuriant vegetation of ferns, *Geranium silvaticum*, etc., and in the crevices large moss-cushions occur everywhere.

the bottom is grass-covered, and several other southern forms, for instance *Eurhynchium Stockesii* and *Isothecium myurum*, likewise have a preference for the sheltered lava-clefts.

In the very deep lava-clefts the conditions are somewhat different from the aforesaid. Where the cleft is broad enough to allow the sun to shine on the bottom during a part of the day, a luxuriant covering of ferns, flowering plants or mosses is found (Fig. 38); but where the cleft is so narrow that the light is strongly subdued, the

higher plants and the *Hylocomium* mats do not thrive. The snow lies here till far into the summer, and in many cases the temperature hardly ever rises above freezing point. The bottom of these clefts is therefore either quite bare of vegetation, or covered only with mosses. At the bottom of narrow clefts (15—20 metres or more in depth) near Thingvellir, where snow and ice were still to be found even at the end of July, Anthelieta occurred on a damp substratum as they do on flats irrigated by melting snow on mountain heights. *Polytrichum sexangulare* and *Pohlia commutata* grew abundantly here as on rocky flats. The plants were considerably higher and more slender than on the rocky flats, and only slightly tomentose. The same was the case with *Conostomum boreale* and *Mniobryum albicans*, which likewise occurred in several clefts. The Bryophyte vegetation occurring there is affected both by the low temperature and also the deficient light and total absence of wind, which all combined contribute to produce a stronger longitudinal growth and a slighter development of rhizoids. Several other species, which have their main distribution on mountain heights, and are rare in or quite absent from the lowlands, are widely distributed about the lava-fields. In almost all the lava-fields of South-west Iceland, *Pleuroclada albescens* var. *islandica*, *Dicranum molle*, *D. Blyttii* and *D. Starckei* are commonly found in clefts, not only in those that are narrow, but especially in the broad moss-grown clefts, where *Dicranum* spp. form large tufts on the blocks of lava.

On the sides of the clefts and of the fallen blocks, a great many mosses grow. *Diplophyllum albicans* is a character-plant of the lava-fields of SW. and W. Iceland; it is extremely common there, but is very rare and scanty in other localities. On the vertical, dry sides of clefts the mosses usually grow in large rounded cushions. The commonest species are *Tortella tortuosa*, *Anœctangium compactum*, *Amphidium Mougeottii*, *Grimmia torquata* and *G. funalis*, but many other of the species occurring on rocks and on the ground are always found both on the walls and also on, and among, the blocks. The Bryophyte vegetation of lava-clefts has the greatest resemblance to that found on the Urd, but some of the most light-loving species are absent, for instance *Orthotrichum*, several *Grimmia* and *Rhacomitrium* spp. and *Dicranoweisia crispula*, while, on the other hand, others are found which belong to damp clefts or which need more shelter. Mesophilous forms are in the majority, whilst hygrophilous forms are, as a rule, entirely absent.

In the following pages some examples of the Bryophyte vegetation of lava-clefts will be described.

Thingvallahraun. The lava-clefts (Icelandic Gjá) there, are peculiar on account of their unusual depth (as much as 20—30 metres). Several of those situated nearest to the lake of Thingvellir have deep water at the bottom.

The Bryophyte carpet at the bottom of the clefts is composed of *Hylocomium loreum, H. proliferum, H. parietinum, H. squarrosum, Hypnum uncinatum, H. callichroum, H. stramineum, H. molluscum, Eurhynchium piliferum, Antitrichia curtipendula, Polytrichum alpinum, Rhacomitrium hypnoides, R. canescens, Dicranum Blyttii, D. Starckei, D. molle, Sphagnum teres, S. Girgensohnii, Lophozia ventricosa, L. quinquedentata, L. Kunzeana, L. alpestris, Ptilidium ciliare* and *Scapania irrigua.* On the sides of the clefts there grew especially *Anœctangium compactum, Grimmia torquata, G. funalis, Gymnostomum rupestre, Amphidium Mougeottii* and *A. lapponicum.* Intermixed with these, and in cushions on the ledges, in the crevices and among the blocks there grew: *Hypnum cupressiforme, Isothecium tenuinerve, Plagiothecium pulchellum, P. denticulatum, P. silvaticum, Amblystegium Sprucei, Neckera complanata, Schistidium gracile, Rhacomitrium sudeticum, Sœlania cæsia, Ditrichum flexicaule, Tortella tortuosa, Fissidens osmundoides, F. bryoides* (rare), *Pohlia cruda, P. commutata, Bartramia ityphylla, Conostomum boreale, Philonotis tomentella, Mnium orthorrhynchum, Bryum pallens, Plagiobryum Zierii, Distichium montanum, Diplophyllum albicans* (in abundance), *Lophozia heterocolpos, Lejeunea cavifolia, Blepharostoma trichophyllum, Alicularia scalaris, A. geoscypha, Anthelia Juratzkana, Scapania subalpina, Pleuroclada albescens* var. *islandica, Cephalozia bicuspidata, Eucalyx subellipticus, Gymnomitrium concinnatum, Metzgeria furcata, Radula complanata, Aneura pinguis* and *Preissia commutata.*

The above list is very long, but is nevertheless hardly complete, since some of the common chomophytes are not enumerated in it, and, at any rate, several of them were undoubtedly forgotten, while the list was being made on the spot, but it gives a good idea of the exceedingly great number of species which are found in these localities.

Hafnarfjardarhraun. Almost the same species are found there as in Thingvallahraun, but the situation close to the sea-side makes its influence felt. *Rhacomitrium heterostichum* and *R. fasciculare* are exceedingly common, and in several places *Ulota maritima*

occurs on lava-blocks and *Trichostomum littorale* on the sides of the clefts. *Scapania dentata* was frequent on the ground at the bottom of shady, damp clefts. *Reboulia hemisphærica* and *Frullania fragilifolia* were found in a single spot on the walls of caves.

On the ground at the bottom of deep, dark caves, shade-forms are often found, especially of *Hepaticæ*, with greatly elongated shoots and expanded, widely scattered leaves. Here, it was especially the following species which were common: *Cephalozia bicuspidata, Pleuroclada albescens* var. *islandica, Alicularia scalaris* and *Blepharostoma trichophyllum*, occasionally also *Preissia commutata* and in a single spot *Ditrichum homomallum* and *Oligotrichum hercynicum*.

Svinahraun is situated about 30 km. south-east of Reykjavik, and about 250—300 metres above sea-level. The part which has been investigated is situated in the neighbourhood of the farm Kolvidarhol, and is of block-lava consisting of blocks and flags piled up into wild-looking heaps, some 10 metres high, with numerous clefts and caves. The top part is covered with an unusually thick and luxuriant mat of *Rhacomitrium hypnoides* from which other mosses and flowering plants are almost absent. On the walls there grew *Amphidium Mougeottii, Tortella tortuosa* and *Anœctangium compactum*. In caves and clefts there was a Bryophyte carpet consisting of *Hypnum uncinatum, H. callichroum, Hylocomium loreum, H. proliferum, H. parietinum, Lophozia quinquedentata, L. lycopodioides, L. Flœrckei, Plagiochila asplenioides* and *Ptilidium ciliare. Diplophyllum albicans* was extremely common everywhere. In addition to the above the following were found more or less abundantly: *Polytrichum alpinum, Diphyscium sessile, Bartramia ityphylla, Conostomum boreale, Mnium orthorrhynchum, Pohlia cruda, P. commutata, Mniobryum albicans, Bryum elegans, Amphidium lapponicum, Rhacomitrium sudeticum, Schistidium gracile, Fissidens osmundoides, Dicranum scoparium, Distichium montanum, Sphagnum teres, Lophozia alpestris, L. quadriloba, Alicularia scalaris, Anthelia Juratzkana* and *Blepharostoma trichophyllum*.

It will be seen that the lava-fields here described greatly resemble each other, and that it is essentially the same species which constitute the bulk of the vegetation in all of them. Svinahraun is situated on the ridge of hills which extends along the whole length of the peninsula of Reykjanes, and the climate there is extremely cold and damp, which is proved by the fact that it is the *Rhacomitrium* heath which forms the last stage in the development

of the vegetation of the flats, and that many of the species of the low land are absent.

Unfortunately there was no opportunity of investigating the lava-fields of West Iceland more closely, since unfavourable atmospheric conditions with rain and fog, combined with a want of time, made a longer stay there impossible, but the conditions appear to be essentially the same as in South-west Iceland.

In his description of Búdahraun Helgi Jónsson has also mentioned some mosses, and, as far as is possible to judge from the lists which, however, are no doubt incomplete, the conditions there are exactly like those in Hafnarfjardarhraun. There also coastal species are found, for instance *Ulota maritima*, and southern species such as *Eurhynchium Stockesii* and *Lejeunea cavifolia*, and the dominant species are quite similar to those in the lava-fields of South-west Iceland.

In North Iceland the Bryophyte vegetation of the lava-fields has an essentially different composition from that in West and South-west Iceland. All the lava-fields there are situated at a distance from the coast, and at a higher level above the sea, the vegetation is therefore decidedly xerophilous both on exposed surfaces and in clefts and crevices. The immense lava-flats at a great height above sea-level, are deserts almost entirely void of vegetation; they have, however, been very little investigated. There are to hand only a few collections from Koch's tour across Odádahraun in 1912, and these consist only of *Tortula ruralis*, *Ceratodon purpureus* and *Dicranoweisia crispula*, which grew here and there upon the lava.

The only lava-field which has been investigated is Mývatnshraun, which is about 160 years old, and upon which the farm Reykjahlid stands. It was described by Grönlund in 1890 and does not appear to have undergone any great change since that time. The *Rhacomitrium* heath occurred only scantily in the depressions, while the lava-cones were bare of vegetation or covered with scattered moss-cushions and crustaceous lichens. In the intervening space between the farm and the lake the following species were observed: Upon the blocks and on the lava were found *Tortula ruralis*, *Ceratodon purpureus*, *Rhacomitrium hypnoides*, *Grimmia Doniana*, *Schistidium confertum*, *Dicranoweisia crispula*, *Polytrichum pilosum* and *Hypnum revolutum*, all of which were very common. In sandy soil, especially in depressions, there grew *Desmatodon latifolius* and *Rhacomitrium canescens*. In dark caves and clefts *Lophozia*

lycopodioides was usually the only species found and it formed there extensive mats. On the ground among the blocks and on the sides of these blocks as also on those of broad clefts there grew *Brachythecium reflexum, Lescuræa filamentosa, Eurhynchium diversifolium* (scantily), *Polytrichum alpinum, Timmia austriaca, Bartramia ityphylla, Encalypta rhabdocarpa, Bryum elegans, B. inclinatum, Schistidium apocarpum, Didymodon rubellus* and *Plagiochila asplenioides.*

The above is a decidedly xerophilous flora from which not only all the mesophilous and hygrophilous forms from SW. Iceland, but also the lowland or southern forms proper, are entirely absent.

In several places in this lava-field the heat of the substratum makes itself felt in deep caves and clefts. In a warm, damp cave where the temperature was about 25° (outside 4°-5°) there grew *Fissidens osmundoides, Plagiothecium denticulatum, Calypogeia Trichomanis, Plagiochila asplenioides* and *Sphagnum rubellum.*

The development of the Bryophyte vegetation of the lava-fields has been very little investigated. The Bryophyta together with the lichens are the first plants which appear. The surface of the lava is very rough, consisting of small round cavities (lava vesicles) in which the spores find favourable conditions for germination, and form small rounded cushions which adhere very closely to the substratum and, if conditions are favourable, extend over the entire surface of the lava as a continuous carpet. It is, however, only in the most exposed parts of the lava-field, that the mosses are confined to the vesicles; this is not the case in the clefts.

Jónsson (1905, pp. 55 and 56) has given a description of Krakatindshraun near Hekla, a lava-field about 23 years old. The mosses grew there only in tiny, scattered cushions upon the lava, without anywhere forming continuous carpets; down in the clefts they grew somewhat more abundantly. There the following species were found: *Bartramia ityphylla, Pohlia cruda, P. commutata, Bryum pallens, Bryum* spp., *Ceratodon purpureus, Dicranoweisia crispula* (the commonest species), *Rhacomitrium hypnoides, R. canescens, Scapania curta* and *Lophozia alpestris.* The further development is exceedingly slow. On the flats *Rhacomitrium hypnoides* will usually grow over all the species and suppress them, but the formation of a continuous *Rhacomitrium* heath appears to require a very long time, in many cases, centuries, and the further development of the moss-heath into heather moor, birch coppice or other formations, through the decay of the mosses and their forming soil, undoubtedly takes place even more slowly.

II. THE BRYOPHYTE VEGETATION OF MOUNTAIN HEIGHTS.

In "Vegetationen paa Snæfellsnes" (Helgi Jónsson, 1900) the plant formations of mountain heights are classified into three groups, viz., Rocky flat, *Grimmia* heath and Mountain bogs. Of these the *Grimmia* heath (*Rhacomitrium* heath) has already been described in a previous section.

Rocky Flat.

By Rocky Flat Jónsson understands that part of the country which is situated above the upper limit of the heather moor (and the birch), with the exception of the mountain bogs and the *Rhacomitrium* heath. Its surface varies greatly, and consists sometimes of gravelly or clayey flats, sometimes of horizontal or sloping stony tracts, bare rocks or talus of débris, all of which, however, have one characteristic in common, viz., that higher plants do not form any continuous carpet, but grow scattered singly or in small societies in the most sheltered localities. The lower limit of the rocky flat varies greatly according to the local conditions. It generally begins at an altitude of about 300—400 metres, but often typical rocky-flat formations are met with at far lower levels, in NW. Iceland, for instance, as far down as to the sea-level.

Bryophyta play a very prominent part in the vegetation of the rocky flat, and are often dominant there, or form special Bryophyte associations.

The dry, gravelly flats are poor in plants, and are often quite devoid of vegetation. Of mosses, as a rule, only *Rhacomitrium hypnoides* is met with in scattered cushions, especially around somewhat large stones, where it can hold fast, and find some shelter. In somewhat damper and less exposed localities *Rhacomitrium* heaths are developed as in the lava-fields of the low land, but whilst the mosses in the low land gradually make room for other plant associations by accumulating the blowing sand around them, and by forming humus, this is not the case on the rocky flat. Here flowering plants occur extremely scantily in the *Rhacomitrium* heath, which therefore forms the final stage in the development of the plant-covering, and is not replaced by other formations.

On large stones on the rocky flat there grew jet-black cushions of *Andreæa petrophila*, *Dicranoweisia crispula*, *Rhacomitrium fasciculare*, *R. sudeticum* and *Schistidium apocarpum*.

On somewhat damper gravelly ground, especially where large blocks lie scattered and afford shelter, the Bryophyte vegetation becomes richer, so that here we sometimes find a continuous carpet of mosses and liverworts, through which the tops of the stones protrude. This carpet of mosses and liverworts is usually composed of a larger or smaller number of the following species: *Hylocomium proliferum, Hypnum uncinatum, Brachythecium reflexum, Lescuræa Breidleri, Rhacomitrium hypnoides, R. fasciculare, R. sudeticum, R. canescens, Schistidium apocarpum, S. gracile, Bryum ventricosum, Pohlia commutata, P. cucullata, P. gracilis, Philonotis fontana, Conostomum boreale, Dicranum Blyttii, D. molle, D. Starckei, D. congestum, Polytrichum sexangulare, Oligotrichum hercynicum, Lophozia alpestris, L. quinquedentata, L. ventricosa, L. lycopodioides, L. Flœrckei, L. quadriloba, Alicularia scalaris, A. geoscypha, Pleuroclada albescens, Anthelia Juratzkana* and *Gymnomitrium concinnatum* besides some rare or more casual species, for instance *Eurhynchium diversifolium, Brachythecium glaciale, Aulacomnium turgidum, Bryum elegans, Bartramia ityphylla, Pohlia Ludwigii, Didymodon rubellus, D. rufus, Desmatodon latifolius, Distichium montanum*, etc. Usually several species grow intermixed, but the moss carpet may also be formed by a single species or a few. At elevations above 500—600 metres *Rhacomitrium sudeticum* often forms extensive growths on gravelly flats. Flowering plants are entirely absent, but lichens *(Cetraria islandica, Cladonia* spp. and *Stereocaulon condensatum)* may occur abundantly in this moss carpet. In the more low-lying parts of the rocky flat *Rhacomitrium sudeticum* rarely occurs abundantly, but is replaced by *Schistidium gracile* and *Schistidium apocarpum*, which form low, blackish-brown or reddish-brown mats. *Lescuræa Breidleri* is a common species, especially in NW. Iceland, where it is in many places the most abundant constituent of the vegetation on stony slopes. *Conostomum boreale* is also common, especially in NW. Iceland where, on the dry gravelly flats of the mountain heights, the intervening spaces between the stones are filled up with its compact tufts. *Brachythecium glaciale* in company with *Hypnum stramineum* covered the damp areas of the rocky flat near Isafjördur, at a height of 450—500 metres. In the channels, in which the water is drained away during the melting of the snow, the stones are often entirely covered with *Mniobryum albicans* var. *glacialis*, and in damp spots and near springs *Philonotis fontana* forms light-green cushions, as it does near the "Dý" in the more low-lying tracts. In the following

pages some examples of the rocky-flat vegetation will be given, it is, however, only in NW., SW. and in a few districts of N. and E. Iceland, that this vegetation has been somewhat closely investigated, whilst the whole of the interior high land is quite unknown as far as bryology is concerned.

1. South Iceland. Barkarstadr, dry stony flat at an altitude of 350 metres: Scattered cushions of *Schistidium apocarpum* v. *rufescens*, *Rhacomitrium hypnoides*, *R. fasciculare*, *Dicranoweisia crispula* and *Andreæa petrophila*.

2. Gravelly flat on Esja, at an altitude of about 550 metres: Moss carpet, partly torn up by the wind, composed of *Hypnum uncinatum* and *Schistidium apocarpum*, scattered in which occur rocky-flat plants such as *Silene acaulis* and *Saxifraga oppositifolia*.

3. Akureyri, rather dry gravelly flat, at an altitude of about 900 metres: Moss carpet composed of *Rhacomitrium hypnoides*, *Hypnum uncinatum*, *Hylocomium proliferum*, *Camptothecium nitens*, *Aulacomnium turgidum*, *Dicranum congestum*, *Didymodon rufus*, *Eurhynchium diversifolium*, *Lophozia quinquedentata* and *L. quadriloba*. Flowering plants entirely absent. On a dry slope at an elevation of about 770 metres there grew *Lescuræa Breidleri*, *Brachythecium glaciale*, *B. reflexum*, *Dicranum Starckei*, *Lophozia lycopodioides* and *L. alpestris*, and on damp gravelly flats near the snow line there grew *Pohlia gracilis* (abundantly), *P. cucullata*, *P. commutata*, *Polytrichum sexangulare*, *Oncophorus virens*, *Dicranum Starckei*, *Lophozia alpestris*, *L. ventricosa*, *L. quinquedentata*, *L. quadriloba*, *Pleuroclada albescens* and *Anthelia Juratzkana*.

Salix herbacea-Sibbaldia Vegetation (Helgi Jónsson, 1900, p. 33) occurs everywhere in damp depressions and on slopes where the subsoil consists of a layer of clay. This vegetation has its main distribution from 300—400 metres to about 700 metres, and here, close to the snow line, it is replaced by pure moss-communities, in which *Salix herbacea* occurs but scantily and at last disappears entirely. The moss community consists of a low, dense carpet of mosses and liverworts, interwoven with creeping stems of *Salix herbacea*, so that only the tips of the shoots protrude above the carpet. The most abundant constituent of this moss carpet is usually a low-growing form of *Hypnum uncinatum* or of *Dicranum Starckei* in association with *Rhacomitrium canescens*, *Dicranum molle*, *Conostomum boreale*, *Polytrichum sexangulare*, *Anthelia Juratzkana*, *Pleuroclada albescens*, species of *Lophozia*, and sometimes other species.

Anthelia flats (Helgi Jónsson, 1900). In damp parts of the rocky flat, especially where the snow-water from the melting snow-flats spreads out over the ground, extensive flats of a greyish-black or bluish-black colour are very commonly met with, and these are principally formed of *Anthelia Juratzkana*. Interspersed in this Anthelietum occur several other Bryophyta of which the most frequent are *Alicularia scalaris, A. geoscypha* and *Lophozia alpestris*, while scattered plants of *Polytrichum sexangulare, Oligotrichum hercynicum* and *Pohlia gracilis* protrude here and there. *Pleuroclada albescens* is also occasionally met with.

Although the *Anthelia* vegetation also occurs in more low-lying tracts, yet it has its main distribution near the snow line, and must therefore be reckoned to the moss associations of the Snow region. There are only a few Bryophyta which occur in the Snow region. At the boundary between the *Anthelia*-flats and the drier gravelly flats *Dicranum falcatum* occurs in semiglobular cushions, densely matted with rhizoids, but it lies so loosely upon the gravel that one can lift up the whole cushion. Near Dyrafjördur *Gymnomitrium varians* grew in a similar manner to *Anthelia*, close to the melting snow-flats. *Dicranum Starckei, D. Blyttii, Pohlia cucullata, P. commutata, Oligotrichum hercynicum* and *Polytrichum sexangulare* are also common near the snow line but, with the exception of a few species (*Dicranoweisia, Andreæa* and *Rhacomitrium* spp.) growing on rocks, the list is thereby exhausted.

Mountain Bogs

are extensively distributed in great parts of Iceland, but have not yet been more closely investigated. The vegetation in the boggy depressions often consists of a low, black mat of *Hypnaceæ*, mostly *Hypnum revolvens, H. exannulatum, H. sarmentosum* and *H. stramineum;* but the moss covering may also contain other species and, in composition, somewhat resemble the bog vegetation of the low land, although the species are fewer in number.

Near Akureyri boggy flats, situated 500—600 metres above sea-level, were partly covered with Hypneta and partly with *Cinclidium stygium* with scattered cushions of *Sphagnum* and species of *Lophozia*. On a wet flat, at an altitude of about 600 metres, there grew *Polytrichum commune* (in abundance), *Hypnum sarmentosum, H. stramineum, H. Lindbergii, H. uncinatum, Dicranum Starckei, Sphagnum teres, S. Girgensohnii, Meesea trichoides, Bryum ventricosum,*



Fig. 39. Rocky flat near Isafjördur, about 500 metres above sea-level. On the larger stones *Rhacomitrium sudeticum* grows in extensive black cushions, and on the ground between the stones Anthelieta and *Dicranum falcatum* occur. To the left in the middle-ground there is a flat with *Rhacomitrium sudeticum*.

Dissodon splachnoides, *Dichodontium pellucidum*, *Aongstrœmia longipes* and *Lophozia Kunzeana*.

Barkarstadr (South Iceland). On a tract of knolly bog-land, 530 metres above sea-level, there grew *Hypnum turgescens*. *H.*

revolvens, H. exannulatum, H. Richardsonii, H. sarmentosum, H. polygamum, Hylocomium squarrosum, Oncophorus Wahlenbergii, Dichodontium pellucidum, Aongstrœmia longipes, Bryum ventricosum, Pohlia gracilis, Dissodon splachnoides, Dicranum congestum (in the *Sphagnum*-tufts), *Sphagnum teres, Alicularia scalaris, Scapania irrigua* and *Anthelia Juratzkana.*

Jud[illegible] from a botanical point of view, the interior high land has be[illegible] very superficially investigated. As regards the mosses, only a few collections are to hand, which were made by A. Wegener during Koch's tour through the island in 1912. But as regards almost all these collections, conditions pertaining to soil and height above sea-level have not been more closely notified.

Hvannalindir (altitude 656 metres): *Hypnum stellatum, H. revolvens, Philonotis fontana, Pohlia commutata* (fr.), *Distichium montanum, Splachnum vasculosum* and *Aongstrœmia longipes.*

Eyolfsfjall (June 22nd): *Aulacomnium palustre, Philonotis tomentella, Bartramia ityphylla, Bryum ventricosum, Cinclidium stygium, Timmia norvegica, Mnium affine* var. *integrifolium, Pohlia cruda, Distichium montanum, Dichodontium pellucidum, Hypnum sarmentosum, Amblystegium Sprucei* and *Anthelia Juratzkana.*

Esjufjall. *Rhacomitrium canescens, R. hypnoides, Distichium montanum, Philonotis tomentella, Mnium orthorrhynchum, Pohlia cruda, Bryum* spp., *Hypnum uncinatum, H. revolutum* and *Anthelia Juratzkana.*

Wet Bogs and River banks; June 22nd (without more particular specification of the locality). *Hypnum exannulatum, H. Kneiffii, Aulacomnium palustre, Philonotis fontana, P. tomentella, Mniobryum albicans* var. *glacialis, Pohlia commutata, Distichium montanum, Schistidium gracile* and *Aongstrœmia longipes.*

These lists almost exclusively contain species which are of common occurrence everywhere.

III. THE COMPONENTS OF THE BRYOPHYTE FLORA.

In consequence of the geographical situation and climate of the island, the vegetation of Iceland has a composition which corresponds most nearly to that of Scandinavia and South Greenland. With the exception of the species found only in Iceland, there is only one species *(Bryoxiphium norvegicum)* which has not been found in the other parts of Europe, but which has its home in North America, and one species *(Tortula obtusifolia)* which I do not think has been found in Scandinavia. The other species are all common to Iceland and Scandinavia. At present it is not possible to compare the Bryophyte flora of Iceland and Greenland, partly because there is no collective account of the distribution of the species found in Greenland, and partly because the older Greenland collections and lists of species greatly need revision.

The Bryophyta found in Iceland can be arranged in four geographical groups (Arnell and Jensen, 1910, p. 238): —

1. Ubiquitous species, which are almost equally distributed over the whole of North Europe as far as north of the Arctic Circle.
2. Meridional species, which are most frequent in Southern Scandinavia and far rarer in Northern Scandinavia.
3. Boreal species, which are more frequent in Northern than in Southern Scandinavia, and have their main distribution below the tree-limit.
4. Alpine species, which have their main distribution above the tree-limit.

In Table II and in the following Tables the plant-geographical character of the species is denoted by the initial letters u, m, b and a, which are prefixed to the name of the species. Icel. indicates that the plant is known only from Iceland. As already mentioned, the species found only on warm soil — almost all of which belong

to the meridional group — are not included in the present or following sections.

Table I. The Plant-geographical Groups.

	u	m	b	a	Icel.
Hepaticæ	28	18	19	22	
Sphagnales	11	2	4		
Musci veri	93	53	88	86	6
Total...	132	73	111	108	6

Of greatest interest in this connection is the comparatively large group of meridional species, which comprise about $^1/_6$ of all the species. According to their distribution in the different districts of Iceland they can be divided as follows: —

a. Found only in the Southern part of Iceland (South Iceland and most nearly adjacent parts of South-east and South-west Iceland).

Reboulia hemisphærica.
Fegatella conica.
Fossombronia Dumortieri.
Aneura multifida.
Marsupella Funckii.
Jamesoniella autumnalis.
Lophozia excisa.
Lophocolea cuspidata.
Lepidozia setacea.
Frullania fragilifolia.
Lejeunea cavifolia.
Sphagnum papillosum.
Weisia crispata.
— viridula.
Trichostomum littorale.
Barbula unguiculata var. cuspidata.
Tortula muralis.
— mucronifolia.
Hedwigia albicans.
Orthotrichum anomalum.
— saxatile.
— cupulatum.
Mnium undulatum.
Leucodon sciuroides.
Anomodon viticulosus.
Thuidium tamariscinum.
— Philiberti.
Isothecium myurum.
Scleropodium purum.
Eurhynchium piliferum.
— Swartzii.
— Stockesii.
Rhynchostegium murale.
Plagiothecium depressum.
— elegans.
Amblystegium fluviatile.
Hypnum molluscum.

b. Most common in South Iceland, rarer in the other parts of the island.

Madotheca Cordæana.
Barbula cylindrica.
Mnium serratum.
Catharinea undulata.
Neckera complanata.
Thuidium delicatulum.
Thamnium alopecurum.
Rhynchostegium rusciforme.
Camptothecium lutescens.
Hypnum commutatum.

c. Found only in a single locality, or in a few localities, in the different parts of Iceland.

Haplozia crenulata.	Bryum bimum.
Lophozia barbata.	Mnium cuspidatum.
Lophocolea minor.	— stellare.
Diplophyllum obtusifolium.	Cylindrothecium concinnum.
Sphagnum angustifolium.	Eurhynchium strigosum.
Dicranum Bonjeani.	Amblystegium serpens.
Trematodon ambiguus.	— Juratzkanum.
Fissidens bryoides.	— trichopodium.
Leptodontium flexifolium.	Hypnum Sommerfeltii.
Barbula fallax.	— Sendtneri.

d. Frequent everywhere, or in large parts of Iceland.

Radula complanata. Common in South, East and West Iceland, absent from North Iceland.

Rhacomitrium aciculare. Very common all over Iceland.

Mnium hornum. Common, especially in South Iceland, rarer in North Iceland.

Pogonatum nanum. Common in several parts of West and South-west Iceland.

Metzgeria furcata. Common over the whole of Iceland.

The majority of the meridional species (a = 37 species and b = 10 species) have a decidedly southerly distribution. Of the species belonging to group c only *Lophozia barbata, Diplophyllum obtusifolium* and *Bryum bimum* have been found, each in a separate locality in East Iceland. The other habitats are equally distributed over South, West and North Iceland.

Table I shows that there is an almost equal number of Boreal and Alpine species and a somewhat larger number of Ubiquists, but in order to obtain a really comprehensive view of these groups, showing which has the greatest importance with regard to the composition of the vegetation, it is also necessary to investigate how many species with a somewhat high degree of frequency are contained in each group.

If all the species are included, the frequency of which — throughout a larger part of Iceland (besides South Iceland) — is expressed by the figure 3 (see p. 644) or upwards, the number of species contained in each group will be as follows: —

Table II. Species with the Frequency of 3 or upwards throughout a larger part of Iceland.

	u	m	b	a	
Hepaticæ	15	3	7	9	
Sphagnales	4				
Musci veri	55	4	49	24	
Total...	74	7	56	33	170

Group 1. Ubiquitous species.

*Marchantia polymorpha.
*Aneura pinguis.
*Pellia Neesiana.
*Alicularia scalaris.
*Lophozia quinquedentata.
— ventricosa.
— Mülleri.
*Plagiochila asplenioides.
*Cephalozia bicuspidata.
* — Hampeana.
*Blepharostoma trichophyllum.
*Ptilidium ciliare
Scapania dentata.
* — undulata.
*Frullania Tamarisci.

Sphagnum Girgensohnii.
* — teres.
— Warnstorffii.
— rubellum.

Gymnostomum rupestre.
Anœctangium compactum.
*Dicranum scoparium.
— congestum.
Ceratodon purpureus.
*Ditrichum flexicaule.
*Didymodon rubellus.
*Tortella tortuosa.
Tortula subulata.
— ruralis.
Schistidium maritimum.
— apocarpum.
* — gracile.
Rhacomitrium heterostichum.
* — canescens.
* — hypnoides.
Amphidium Mougeottii.
Ulota maritima.
Orthotrichum rupestre.
Encalypta rhabdocarpa.
Funaria hygrometrica.
*Leptobryum pyriforme.
*Pohlia cruda.
*Bryum inclinatum.
— argenteum.
— pallens.
* — ventricosum.
*Mnium affine.
— Seligeri.
* — punctatum.
Meesea triquetra.
*Aulacomnium palustre.
*Bartramia ityphylla.
*Philonotis fontana.
Pogonatum urnigerum.
Polytrichum juniperinum.
Diphyscium sessile.
Fontinalis antipyretica.
Antitrichia curtipendula.
*Pterigynandrum filiforme.
*Climacium dendroides.
Brachythecium albicans.
Plagiothecium Rœseanum.
*Hypnum stellatum.
* — uncinatum.

*Hypnum exannulatum.
* — filicinum.
— cupressiforme.
* — Lindbergii.
* — stramineum.
*Acrocladium cuspidatum.
*Scorpidium scorpioides.
*Hylocomium proliferum.
* — parietinum.
* — squarrosum.

Group 2. Meridional species.

Metzgeria furcata.
Madotheca Cordæana.
Radula complanata.
*Rhacomitrium aciculare.
Mnium hornum.
Catharinea undulata.
Camptothecium lutescens.

Group 3. Boreal species.

*Alicularia geoscypha.
*Lophozia lycopodioides.
* — Kunzeana.
*Chiloscyphus polyanthus.
*Cephalozia pleniceps.
*Scapania irrigua.
* — curta.

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*Andreæa petrophila.
*Dichodontium pellucidum.
*Oncophorus Wahlenbergii.
* — virens.
Dicranella squarrosa.
* — crispa.
Dicranum Blyttii.
Fissidens osmundoides.
*Blindia acuta.
*Distichium montanum.
Tortella fragilis.
Grimmia torquata.
*Rhacomitrium sudeticum.
* — fasciculare.
*Amphidium lapponicum.
Encalypta ciliata.
Dissodon splachnoides.
Splachnum sphæricum.
* — vasculosum.
*Pohlia gracilis.
*Mniobryum albicans.
Bryum purpurascens.
— lacustre.
— affine.
— cirratum.
Bryum pallescens.
* — Duvalii.
*Mnium cinclidioides.
*Paludella squarrosa.
*Meesea trichoides.
*Catoscopium nigritum.
*Philonotis tomentella.
*Timmia austriaca.
Polytrichum strictum.
— gracile.
*Myurella julacea.
— tenerrima.
Lescuræa filamentosa.
Thuidium lanatum.
*Camptothecium nitens.
Brachythecium reflexum.
* — rivulare.
Plagiothecium pulchellum.
*Hypnum polygamum.
* — revolvens.
— Kneiffii.
— decipiens.
* — falcatum.
* — giganteum.
Hylocomium rugosum.

Group 4. Alpine species.

*Gymnomitrium concinnatum.
*Haplozia cordifolia.
— atrovirens.
Lophozia quadriloba.
* — alpestris.
Pleuroclada albescens.
Anthelia julacea.
* — Juratzkana.
*Scapania subalpina.

*Dicranoweisia crispula.
Aongstrœmia longipes.
Dicranum falcatum.
* — Starckei.
— molle.
Desmatodon latifolius.
*Schistidium rivulare.
Grimmia Doniana.
* — funalis.
Tetraplodon bryoides.
*Pohlia commutata.
Bryum arcticum.

*Mnium orthorrhynchum.
Conostomum boreale.
Philonotis seriata.
Psilopilum lævigatum.
— hercynicum.
*Polytrichum alpinum.
— sexangulare.
Amblystegium Sprucei.
*Hypnum revolutum.
— alpestre.
* — ochraceum.
* — sarmentosum.

The species to which an asterisk has been prefixed have everywhere, or throughout the larger part of Iceland, the degree of frequency expressed by figure 4 (see p. 644), and consequently they constitute the bulk of the vegetation. Groups 1 and 3 include conjointly 75 (41 + 34) species, while group 4 has 15, and group 2 only one species which is very common everywhere.

IV. THE ALTITUDINAL DISTRIBUTION OF THE SPECIES.

There are only a few species which are equally common in the low land and on mountain heights. The majority of them are either Lowland forms, which rapidly decrease in frequency above a certain altitude and at last disappear completely, or Alpine forms which have their main distribution at greater heights above sea-level and decrease in frequency downwards. In countries with a continental climate it is, as a rule, not difficult to draw a somewhat sharp limit for the altitudinal distribution of plants, but the conditions for survey are far less favourable in a country like Iceland, where a cold and damp insular climate prevails in the coastal districts. On account of the low summer temperature, the majority of the Alpine species can thrive as far down as the low land, and conversely many of the lowland mosses will be able to establish colonies in favourable localities, which are situated essentially higher than their usual limit of growth. In South Iceland, for instance, I have seen a southern slope, at an altitude of above 500 metres, which was covered with species of *Hylocomium* together with other species belonging to the same formation.

As regards Iceland a fairly distinct boundary line may be drawn between the Lowland and Highland formations by taking the upper limit of the heather moor (and of the birch) as a basis for the classification (Helgi Jónsson, 1895—1899—1900); it is then seen that the upper limit of growth of a very great number of Bryophyta nearly coincides with the upper limit of the heather moor. The upper limit of the heather moor varies somewhat in the different parts of Iceland, and is also in a high degree dependent on local conditions such as shelter, direction of exposure, and conditions pertaining to moisture. In East Iceland the boundary line lies, as a rule, at about 300 metres, and the same is the case in the greater part of South-west, West and North Iceland. Around Mývatn, ac-

cording to Thoroddsen's statement, the birch coppices ascend to 550 metres. In North-west Iceland the birch coppices in Dýrafjördur ascend to about 270 metres, and around Isafjardardjup probably not very far above 200 metres. In South Iceland the upper limit of the heather moor generally lies at an altitude of 300—350 metres, but in sheltered valleys both birch coppices and heather moor may be met with at an altitude of above 500 metres. On the whole, the upper limit of the heather moor may, however, be reckoned to lie, on an average, at an altitude of about 300—350 metres.

All that is situated above this limit is in the following designated the Alpine region, since the willow region which occurs in the mountains of Scandinavia and Central Europe is not typically developed in Iceland; not, at any rate, in the coastal districts. The reason for this must in a great measure be sought in the geological structure of the country. The gradually-ascending or terrace-formed land near to the coast rises to a height of 200–300 metres, and from here the mountains almost everywhere shoot abruptly upwards to a height of 600—700 metres, right up to the plateau on the mountain summit, from which again a few peaks or rock-masses protrude. This leaves very little room for vegetation between 300 and 600 metres, with the exception of the valleys, which are, as a rule, very narrow. This is very decidedly noticeable in North-west and East Iceland, where almost everywhere along the coasts, from a quite narrow coast-land, the mountains rise abruptly to an almost constant height of 600 metres, so that only at the head of the valleys do terraces occur at various levels as far upwards as the mountain heights. In North Iceland, especially towards the east, the country rises more gradually up towards the interior high land, and there — at any rate somewhat inland — willow coppices and willow swamps occur also, but their Bryophyte vegetation has been very little investigated.

Taking the above as a basis the vegetation may be classified into zones, according to altitude.

A. The Lowland region which reaches to the upper limit of the heather moor and the birch.

B. The Mountain region which includes slopes and flats to a height of about 600 metres.

C. Alpine Heights (the Snow region) to which is reckoned all that is situated higher than about 600–700 metres. The vegetation there is very poor in species, and is strongly affected

by the severe climate and the snow, which remains over extensive tracts till late in the summer, and saturates the soil with ice-cold snow-water.

In the following table the first column consists of the species which have been found in the Lowland region, the second column the species which have been found in the Mountain region, and the third the species which have been found in the Snow region. A cross (+) indicates that the species has its main distribution in the region in question; a dash (—) indicates that the species in question decreases in frequency and extends to a more or less high level (or low level) in the region in question, and a dot (·) indicates, that the species has been found only in a few places close to the boundary of the region to which it belongs, or that it has, on the whole, been found so scantily that no opinion can be formed with regard to its distribution within the different altitudinal regions.

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions.

	Up to 300 m.	300—600 m.	Above 600 m.
Hepaticæ.			
Sauteria alpina	·		
Reboulia hemisphærica	+		
Fimbriaria pilosa	·		
Fegatella conica	+		
Preissia commutata	+		
Marchantia polymorpha	+	—	
Aneura multifida	+		
— latifrons	+		
Pellia Neesiana	+	·	
Metzgeria furcata	+		
Blasia pusilla	+		
Fossombronia Dumortieri	·		
Gymnomitrium coralloides	+	—	
— concinnatum	—	+	+
— varians		·	
— revolutum	·		
Marsupella Funckii	·	·	
— emarginata	·	·	·
— aquatica	·		

	Up to 300 m.	300—600 m.	Above 600 m.
Alicularia scalaris	+	+	—
— geoscypha	+	+	+
Eucalyx subellipticus	+	·	
Haplozia crenulata	+		
— sphærocarpa	·	·	
— cordifolia	+	—	
— riparia	+		
— atrovirens	+	—	
— pumila	·		
Jamesoniella autumnalis	·		
Sphenolobus minutus	·		
— politus	·		
Lophozia quinquedentata	+	+	+
— lycopodioides	+	—	·
— Flœrckei	+	+	
— quadriloba	+	+	·
— Kunzeana	+	+	—
— barbata	+		
— ventricosa	+	+	+
— Wenzelii	+	·	
— alpestris	+	+	+

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.
Lophozia excisa	·	·	
— Schultzii	+		
— Mülleri	+	—	
— Hornschuchiana	+	—	
— heterocolpos	+	—	
Gymnocolea inflata	·		
Plagiochila asplenioides	+	—	·
Leptoscyphus anomalus	·		
Lophocolea cuspidata	+		
— minor	+		
Chiloscyphus polyanthus	+	·	
Harpanthus Flotowianus	+		
Cephalozia bicuspidata	+	—	
— ambigua	·		
— pleniceps	+	—	
— media	·		
Pleuroclada albescens		—	+
— var. islandica	+		
Cephaloziella Hampeana	+	—	
— rubella	+	—	
Odontoschisma elongatum	+	·	
— denudatum	·		
— Macouni	+		
Lepidozia setacea	·		
Blepharostoma trichophyllum	+	+	
Anthelia julacea	+	—	
— Juratzkana	—	+	+
Ptilidium ciliare	+	—	·
Diplophyllum albicans	+		
— obtusifolium	·		
Scapania subalpina	+	·	
— remota		·	
— irrigua	+	—	·
— uliginosa	+	—	
— paludosa	+		
— dentata	+	·	
— undulata	+	—	
— curta	+	—	·
— Bartlingii	·		
Radula complanata	+		
Frullania dilatata	·		

	Up to 300 m.	300—600 m.	Above 600 m.
Frullania Tamarisci	+		
— fragilifolia	+		
Madotheca Cordæana	+		
Lejeunea cavifolia	+		
Sphagnales.			
Sphagnum medium	+		
— papillosum	+		
— inundatum	+		
— Gravetii	·		
— compactum	·		
— teres	+	+	
— squarrosum	+		
— fimbriatum	+	—	
— Girgensohnii	+	—	
— Russowii	·		
— Warnstorffii	+	—	
— rubellum	+	—	
— acutifolium	+		
— subnitens	+		
— Lindbergii	·		
— riparium	+		
— angustifolium	·		
Musci veri.			
Andreæa petrophila	+	+	+
Gymnostomum rupestre	+		
Hymenostylium curvirostre	+		
Anœctangium compactum	+		
Weisia crispata	+		
— viridula	+		
— Wimmeriana	·		
Dicranoweisia crispula	+	+	+
— compacta	·		
Cynodontium polycarpum	·		
Dichodontium pellucidum	+	—	
Aongstrœmia longipes	+	+	
Oncophorus virens	+	+	—
— Wahlenbergii	+	+	—
Dicranella squarrosa	+	+	
— Schreberi	+		

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.
Dicranella crispa	+		
— cerviculata	+		
— subulata	+		
Dicranum fulvellum	·	+	·
— Andersonii	+		
— falcatum		—	+
— Blyttii	·	+	+
— Starckei	·	+	+
— molle	—	+	—
— Bonjeani	+		
— angustum	+	—	
— majus	+		
— scoparium	+	—	·
— fuscescens	+	—	
— congestum	+	+	—
— spadiceum	+		
— elongatum	+		
Campylopus Schimperi	+		
Trematodon ambiguus	+		
Fissidens bryoides	+		
— osmundoides	+	·	
— decipiens	·		
— adianthoides	+		
Blindia acuta	+	—	
Ceratodon purpureus	+	+	—
Ditrichum tortile	+		
— nivale		·	
— homomallum	+		
— flexicaule	+	+	
Sælania cæsia	+		
Distichium montanum	+	+	·
— inclinatum	+		
Bryoxiphium norvegicum	+		
Pottia Heimii	+		
— latifolia	·		
Didymodon rubellus	+	—	
— rufus	+		·
Leptodontium flexifolium	·		
Trichostomum littorale	·		
Tortella inclinata	·		
— tortuosa	+	—	
Tortella fragilis	+	—	
Barbula unguiculata	+		
— fallax	+		
— cylindrica	+		
— icmadophila	+		
Desmatodon latifolius	+	—	
— cernuus	·		
Tortula obtusifolia	·		
— muralis	+		
— subulata	+	·	
— mucronifolia	+		
— ruralis	+	—	
— aciphylla	·		
Schistidium maritimum	+		
— apocarpum	+	+	·
— gracile	+	+	—
— confertum	+		
— alpicola	·		
— — v. rivularis	+	·	
Grimmia commutata	·		
— Doniana	+	—	
— alpestris	+		
— ovata	+		
— incurva	·		
— patens	+		
— funalis	+	—	
— torquata	+		
Rhacomitrium sudeticum	+	+	—
— heterostichum	+	—	·
— microcarpum	·		
— canescens	+	+	+
— hypnoides	+	+	+
— fasciculare	+	+	+
— aciculare	+	·	
Hedwigia albicans	+		
Amphidium lapponicum	+	·	
— Mougeottii	+		
Ulota phyllantha	+		
Orthotrichum anomalum	+		
— saxatile	+		
— cupulatum	+		

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.
Orthotrichum rupestre	+	·	
— Sturmii	+		
— Killiasii	+		
— Blyttii	+		
— lævigatum	·	·	
Encalypta ciliata	+		
— rhabdocarpa	+	—	
— contorta	·		
Dissodon splachnoides	+	+	
Tetraplodon bryoides	+		
Splachnum sphæricum	+	·	
— vasculosum	+	+	·
Funaria hygrometrica	+		
Leptobryum pyriforme	+		
Anomobryum filiforme	+		
— concinnum	·		
Plagiobryum Zierii	+		
— demissum	·		
Pohlia acuminata	+		
— polymorpha		·	
— cruda	+	+	—
— nutans	+	—	
— cucullata	·	+	+
— Ludwigii		+	
— commutata	—	+	+
— gracilis	—	+	+
— Rothii	+		
— tenuifolia	+		
— grandiflora	+		
— proligera	·		
Mniobryum albicans	+	+	+
Bryum purpurascens	+	·	
— lacustre	+		
— Kaurini	·		
— archangelicum	+		
— Jörgensenii	·		
— inclinatum	+		
— retusum	+		
— islandicum	·		
— Grœnlundii	·		
— calophyllum	·		

	Up to 300 m.	300 – 600 m.	Above 600 m.
Bryum uliginosum	+		
— fallax	·		
— œneum	+	—	
— bimum	·		
— affine	+		
— cirratum	+		
— intermedium	+		
— pallescens	+		
— subrotundum	·		
— capillare	+		
— cæspiticium	+		
— comense	·		
— elegans	+	—	
— argenteum	+		
— neodamense	·		
— Duvalii	+	·	
— pallens	+	·	
— ventricosum	+	+	·
— arcticum	+		
— pendulum	+		
— Brownii	·		
Mnium hornum	+		
— orthorrhynchum	+	—	
— serratum	+		
— spinosum	+		
— undulatum	+		
— cuspidatum	+		
— medium	+		
— affine	+	—	
— Seligeri	+		
— stellare	+		
— cinclidioides	+	—	
— punctatum	+	—	
— subglobosum	+		
Cinclidium stygium	+	+	
Paludella squarrosa	+	—	
Amblyodon dealbatus	·		
Meesea trichoides	+	—	
— triquetra	+		
Catoscopium nigritum	+	·	
Conostomum boreale	—	+	+

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.
Aulacomnium palustre	+	+	·
— turgidum	+	+	·
Bartramia ityphylla	+	+	—
Plagiopus Œderi	·		
Philonotis fontana	+	+	+
— Arnellii	·		
— seriata	+	+	
— tomentella	+	+	·
Timmia norvegica	+	·	
— austriaca	+	—	·
Catharinea undulata	+		
Oligotrichum hercynicum	—	+	+
Psilopilum lævigatum	+		
Pogonatum polytrichoides	+		
— dentatum var. minus	·		
— urnigerum	+	·	
Polytrichum alpinum	+	+	—
— formosum	·		
— gracile	+		
— sexangulare	·	—	+
— — var. tenellum	+	·	
— piliferum	+		
— juniperinum	+	—	
— strictum	+	—	
— commune	+	—	
— Swartzii	+		
Diphyscium sessile	+	+	·
Fontinalis antipyretica	+	—	
— islandica	·		
— longifolia	·		
— thulensis	·		
— androgyna	·		
Leucodon sciuroides	+		
Antitrichia curtipendula	+		
Neckera complanata	+		
Myurella julacea	+	·	
— tenerrima	+	·	
Leskea nervosa	+		
— catenulata	·		
Anomodon viticulosus	+		
Pterigynandrum filiforme	+	·	
Lescuræa decipiens	·		
— radicosa	·		
— filamentosa	+	—	
— Breidleri	·	+	—
— patens	+	—	
Heterocladium squarrosulum	+		
Thuidium tamariscinum	+		
— delicatulum	+		
— Philiberti	+		
— abietinum	+		
— lanatum	+	—	
Orthothecium rufescens	·		
— intricatum	+		
— chryseum	+	—	
Cylindrothecium concinnum	·		
Climacium dendroides	+		
Isothecium myurum	+		
— tenuinerve	+		
Homalothecium sericeum	+	—	
Camptothecium lutescens	+		
— nitens	+	+	
Brachythecium Mildeanum	+		
— salebrosum	+	—	
— collinum	·		
— populeum	+		
— velutinum	+		
— glaciale		+	+
— reflexum	—	+	—
— longipilum	·		
— glareosum	+		
— albicans	+	—	
— erythrorrhizon	+		
— rivulare	+	—	
— latifolium	·		
Scleropodium purum	+		
Eurhynchium strigosum	+		
— diversifolium	·	·	·
— cirrosum	+		
— piliferum	+		
— Swartzii	+		

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.
Eurhynchium Stockesii	+		
Rhynchostegium murale	+		
— rusciforme	+		
Thamnium alopecurum	+		
Plagiothecium silvaticum	+		
— Rœseanum	+	·	
— denticulatum	+		
— pulchellum	+	·	
— depressum	+		
— elegans	·		
Amblystegium Sprucei	+	—	
— fluviatile	·		
— serpens	+		
— Juratzkanum	+		
— littorale	+		
— compactum	+		
— salinum	+		
— trichopodium	+		
Hypnum Sommerfeltii	·		
— chrysophyllum	+		
— protensum	+		
— stellatum	+	+	—
— polygamum	+		
— intermedium	+	+	
— revolvens	+	+	
— uncinatum	+	+	—
— Sendtneri	·		
— Kneiffii	+	·	
— exannulatum	+	+	
— — var. purpurascens	+	+	
— — var. Rotæ	+		
— — var. serratum	·		
— fluitans	+		
— — v. falcatum	·		
Hypnum filicinum	+	—	
— curvicaule	—	+	
— decipiens	+		
— commutatum	+		
— — v. falcatum	+		
— molluscum	+		
— imponens	+		
— Bambergeri	·		
— revolutum	+	—	·
— cupressiforme	+		
— hamulosum	+	—	
— callichroum	+		
— Lindbergii	+	—	
— palustre	+		
— arcticum	·		
— alpestre	+	·	
— alpinum	+		
— ochraceum	+	·	
— cordifolium	+		
— Richardsonii	+	—	
— giganteum	+	—	
— stramineum	+	+	—
— sarmentosum	+	+	—
— trifarium	·	·	
— turgescens	+	—	
Acrocladium cuspidatum	+	·	
Scorpidium scorpioides	+	·	
Hylocomium proliferum	+	+	—
— pyrenaicum	·		
— parietinum	+	·	
— loreum	+	·	
— triquetrum	+	·	
— squarrosum	+	—	
— rugosum	+	·	

Table I shows that of the 424 species enumerated in it (the habitat of *Sphenolobus saxicola* is not known) 416 occur in the low land, and that only 8 species *(Gymnomitrium varians, Pleuroclada*

albescens, Scapania remota, Ditrichum nivale, Pohlia polymorpha, P. Ludwigii and *Brachythecium glaciale)* have not been found below the upper limit of the birch.

In the Mountain region the number of species is as follows: —

42 Hepaticæ
5 Sphagna
134 Musci veri

181 Total species.

Of these, however, 10 Hepaticæ and 31 Musci veri have been found only in the lowest part, at the boundary towards the Lowland region, whereby the number of species which in reality belong to the Mountain region, is reduced to 140. Of these, 2 Hepaticæ, viz. *Gymnomitrium varians* and *Scapania remota* and 3 Musci veri, viz. *Ditrichum nivale, Pohlia polymorpha* and *P. Ludwigii* have been found only in this region.

In the Snow region the number of species is as follows: — 16 Hepaticæ, 42 Musci veri, total 58, of which, 6 Hepaticæ and 10 Musci have been found only in a few localities and cannot be regarded as belonging to this region. In all, 42 species remain, of which, however, only 8 Hepaticæ and 20 Musci veri are fairly frequent, while the others have been found only in a few localities. The majority of the species belong to those which are of equal frequency at all altitudes, and only 4 species *(Pleuroclada albescens, Dicranum falcatum, Pohlia cucullata* and *Polytrichum sexangulare)* can be designated true Snow-region species.

The number of species decreases rapidly as the height above sea-level increases, and even at the upper limit of the heather moor the number falls to about 40 % of the total number of species. Above a height of about 600 metres the number scarcely reaches 15 % of all the species.

V. THE HORIZONTAL DISTRIBUTION OF THE SPECIES.

In order to obtain a correct notion of the importance of each plant-species within a floral district it is necessary to know not only their distribution in the different parts of this district, but also their relative abundance (number of individuals) in comparison with other species. The following Table gives a summary of all the Bryophyta found in Iceland, with the exception of the species growing in warm soil, since, as regards these species, it is chiefly the heat of the soil and not the climatic conditions which determine their distribution. The frequency within the different districts is indicated by the figures 1—4, so that 1 indicates rare or very scantily occurring species; 2 those that occur here and there or only in a comparatively few localities and not in abundance; 3 frequent, but as a rule playing no important part in the moss-covering, or occurring only locally in abundance; and 4 the common and abundantly occurring species.

The majority of the species are not equally distributed in all the different altitudinal regions, and the frequency is therefore reckoned relatively to the region in which each species is most widely distributed. As regards species which grow only in quite definite areas (for instance littoral species) the frequency is reckoned separately.

The figures in the table are, however, in many cases somewhat doubtful, since many districts are too superficially investigated to allow one to form an opinion as to the frequency of the less commonly occurring species. This is the case, for instance, as regards the majority of the districts of East Iceland situated above an altitude of 300 metres, because in June, when I travelled through this part of the country, the mountains were still for a great part snow-covered, which in connection with continual fog made investigation almost impossible.

It must also be noted that the table is based only on the

coastal districts, and on the low land with the neighbouring heights. The high land of the interior, which is about 90,000 km². in dimension and, usually, 600—1000 metres in height, is from a botanical point of view practically unknown. Outside the Jökulls it consists almost everywhere of gravelly flats which are practically bare of vegetation. According to Thoroddsen, however, there are in some places extensive mountain-bogs, but the Bryophyte vegetation of these is quite unknown.

Table IV. The Frequency of the Species in the different Districts of Iceland.

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
	Hepaticæ.					
a	Sauteria alpina		1*			
m	Reboulia hemisphærica					3*
a	Fimbriaria pilosa		1*	1*		
m	Fegatella conica					4
u	Preissia commutata		2*	1	2	3*
u	Marchantia polymorpha	4*	4*	4*	4*	4*
u	Aneura pinguis	4	4	4*	4	4*
m	— multifida					1
u	— latifrons		1	1	1	
u	Pellia Neesiana	4	4*	4	4	4
m	Metzgeria furcata	3	3	3	3	4
u	Blasia pusilla		2		1	
m	Fossombronia Dumortieri					1
a	Gymnomitrium corallioides	3	2		3	2
a	— concinnatum	4*	4*	4*	4*	4*
a	— varians		1	1		
a	— revolutum			1		
u	Marsupella emarginata			1		2
u	— aquatica			1		
m	— Funckii	1				1
u	Alicularia scalaris	4*	4*	4*	4*	4*
b	— geoscypha	4*	4*	4*	4*	4*
a	Eucalyx subellipticus	2*	1*	2*	1*	1*
b	Haplozia sphærocarpa			1		
a	— cordifolia	4*	4*	4*	4*	4*
b	— riparia					3*
a	— atrovirens	3*	3*	3*	3*	3*
b	— pumila		1*			
m	— crenulata			1	1	
m	Jamesoniella autumnalis					1

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	Sphenolobus minutus	1		1	1	
b	— saxicola?					
a	— politus			1*		
u	Lophozia quinquedentata	4	4*	4*	4	4
b	— lycopodioides	4	4	4	4	3
b	— Flœrckei			4	2	
a	— quadriloba	3	2	2	2	2
b	— Kunzeana	4	4	4	4	4
m	— barbata	1			2	1
u	— ventricosa	3	3	4*	3	3
a	— Wenzelii	1	1*	1*	1	
a	— alpestris	4	4	4*	4*	4*
m	— excisa					1*
b	— Schultzii	1	1		1*	
u	— Mülleri	3	3	3	3	3
a	— Hornschuchiana	2	1*	1	2	
b	— heterocolpos		1	1	1	1
u	Gymnocolea inflata			1		
u	Plagiochila asplenioides	4	4	4	4	4
u	Leptoscyphus anomalus	1				
m	Lophocolea cuspidata					2
m	— minor		1			1
b	Chiloscyphus polyanthus	4	4	4	4	4
b	Harpanthus Flotowianus	1	1	4	2	
u	Cephalozia bicuspidata	4*	4*	4*	4*	4*
a	— ambigua			1*		
b	— pleniceps	3*	3*	4*	3*	?
b	— media		1*	1*		
a	Pleuroclada albescens	3	3	4	2	
a	— — var. islandica		1			2
u	Cephaloziella Hampeana	4*	4*	4*	4*	4*
u	— rubella	1	1	2	1	1
u	Odontoschisma elongatum	2	1		3	1
u	— denudatum				1	
a	— Macouni	1	1		1	
m	Lepidozia setacea					1
u	Blepharostoma trichophyllum	4	4*	4	4	4*
b	Chandonanthus setiformis?					
a	Anthelia julacea	3*	3*	3*	3*	3*
a	— Juratzkana	4*	4*	4*	4*	4*
u	Ptilidium ciliare	4	4	4	4	4
u	Diplophyllum albicans				3	3
m	— obtusifolium	1	1			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	Scapania subalpina	4*	4*	4*	4*	4*
a	— remota		1			
b	— irrigua	4?	4*	4	4	4*
b	— uliginosa	1		3		
b	— paludosa			3*		
u	— dentata	3*	1*		2*	3*
u	— undulata	4*	4*	4*	4*	4*
b	— curta	4*	4*	4*	4*	4*
a	— Bartlingii					1
m	Radula complanata	3	1*		3	3*
m	Madotheca Cordæana	2		2	3	4
u	Frullania dilatata				1	
u	— Tamarisci	4	4	4	4	4
m	— fragilifolia				1	1
m	Lejeunea cavifolia				1	3
	Sphagnales.					
b	Sphagnum medium			1	1	2
m	— papillosum				2	2
u	— inundatum				1	1
u	— Gravetii			1		
b	— compactum					1
u	— teres	4	4	4	4	4
u	— squarrosum		1	3		
u	— fimbriatum		2	2	3	1
n	— Girgensohnii	3	3	3	3	3
b	— Russowii					1
u	— Warnstorffii	3	3	3	3	3
u	— rubellum	3	3	3	3	3
u	— acutifolium		1	1	1	1
u	— subnitens			1	2	2
b	— Lindbergii				1	
u	— riparium			3		
m	— angustifolium		1			
	Musci veri.					
b	Andreæa petrophila	4*	4*	4*	4*	4*
u	Gymnostomum rupestre	1	3		3	3
b	Hymenostylium curvirostre		1		1	3*
u	Anœctangium compactum	4			3	4
m	Weisia crispata				1	1*
m	— viridula					1*
a	— Wimmeriana		1*			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	Dicranoweisia crispula	4*	4*	4*	4*	4*
a	— compacta		1			
u	Cynodontium polycarpon	1*				
b	Dichodontium pellucidum	4*	4*	4*	4*	4*
a	Aongstrœmia longipes	3	3*	1	2	2
b	Oncophorus Wahlenbergii	4*	4*	4*	4*	4*
b	— virens	4*	4*	4*	4*	4*
b	Dicranella squarrosa	2	3*	4	2	1
u	— Schreberi		1		1	
b	— crispa	4*	4*	4*	4*	4*
b	— subulata		1	1		1
u	— cerviculata			2	2	1
a	Dicranum fulvellum					3*
a	— Andersonii	1*				3*
a	— falcatum	2*	2*	3*	2*	3*
b	— Blyttii	1*	1*	3*	3*	3*
a	— Starckei	4*	4*	4*	4*	4*
a	— molle	1*	1*	4*	3*	1*
m	— Bonjeani	1	1		2	
b	— angustum	3	1	1	2	1
u	— majus			3	1	
u	— scoparium	4	4	4*	4*	3*
u	— fuscescens			4*	1	
u	— congestum	4	4	?	3	2
a	— spadiceum	2	1		1	
a	— elongatum		2	2	2	
a	Campylopus Schimperi	1	1		2	1
m	Trematodon ambiguus				1	
m	Fissidens bryoides		1*			1*
b	— osmundoides	3	3	3	3*	3
u	— adianthoides		1*		2*	
u	— decipiens				1	
b	Blindia acuta	4*	4*	4*	4*	4*
u	Ceratodon purpureus	2*	3*	3*	3*	2*
u	Ditrichum tortile	1				
a	— nivale	1				
u	— homomallum	1	1		2*	1
u	— flexicaule	4*	4	4	4	4
a	Sælania cæsia	2*	2*		3*	2*
b	Distichium montanum	4*	4*	4*	4*	4*
u	— inclinatum	1*	2*	1*		
a	Bryoxiphium norvegicum					3
u	Pottia Heimii	2*	3*	1*	3*	3*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	Pottia latifolia		1*			
u	Didymodon rubellus	4*	4*	4*	4*	4*
b	— rufus	1	1		1	
m	Leptodontium flexifolium		1			
m	Trichostomum littorale				1	1
u	Tortella inclinata	1				
u	— tortuosa	4	4	4	4	4
b	— fragilis	3	3	3	3	3
m	Barbula unguiculata var. cuspidata				1	1
m	— fallax				1	1
m	— cylindrica		1		1	3*
a	— icmadophila	1	1		1	
a	Desmatodon latifolius	3*	2*	3*	2*	
a	— cernuus		1*			
a	Tortula obtusifolia					1*
m	— muralis					1*
u	— subulata	3*	3*	3*	3*	3*
m	— mucronifolia					1*
u	— ruralis	2*	3*	3*	2	2
a	— aciphylla			1*		
u	Schistidium maritimum	3*	3*	3*	3*	3*
u	— apocarpum	3*	3*	3*	3*	3*
u	— gracile	4*	4*	4*	4*	4*
b	— confertum	1*	2*			
a	— alpicola		1*			
a	— — var. rivularis	4*	4*	4*	4*	3*
b	Grimmia commutata		1		1	
a	— Doniana	3*	2*	2*	3*	3*
a	— alpestris	1				1*
b	— ovata	2	2			
a	— incurva	1				
u	— patens	1			1	
a	— funalis	4*	4*	4*	4*	4*
b	— torquata	2	1	2	3	4
b	Rhacomitrium sudeticum	4*	3*	4*	3*	3*
b	— microcarpum		1			
u	— heterostichum	3	2	2	4	4
u	— canescens	4*	4	4*	4	4
u	— hypnoides	4	4	4	4	4
b	— fasciculare	4*	3*	3*	4*	4*
m	— aciculare	4*	4*	4*	4*	4*
m	Hedwigia albicans					1
b	Amphidium lapponicum	4*	4*	4*	4*	4*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	Amphidium Mougeottii	3	2	3	4	4
u	Ulota phyllantha	3	3	3	3	3
m	Orthotrichum anomalum					1*
m	— saxatile					1*
m	— cupulatum					1*
u	— rupestre	3*	3*	3*	3*	3*
u	— Sturmii	1*			1*	
a	— Killiasii	1*	1*		?	
a	— Blyttii	2*	1*	1*	1*	
a	— lævigatum		2*	1*	1*	
b	Encalypta ciliata	3*	2*		3*	3*
u	— rhabdocarpa	3*	3*	3*	3*	3*
u	— contorta				1	
b	Dissodon splachnoides	1*	4*	3*	1*	1*
a	Tetraplodon bryoides	2*	2*	2*	2*	2*
b	Splachnum sphæricum	3*	3*	2*	2*	2*
b	— vasculosum	3*	3*	3*	3*	3*
u	Funaria hygrometrica	3*	3*	3*	3*	3*
u	Leptobryum pyriforme	4*	4*	2*	3*	4*
a	Anomobryum filiforme	2		1	2	3*
a	— concinnum					1
b	Plagiobryum Zierii	2	1	1	2	2*
a	— demissum				1*	
a	Pohlia acuminata				1*	2*
a	— polymorpha				1	
u	— cruda	4*	4*	4*	4*	4*
u	— nutans	1*	1*	3*	1*	2*
a	— cucullata		1*	2*		
a	— Ludwigii		1*			
a	— commutata	4*	4*	4*	4*	4*
b	— gracilis	4*	4*	4*	4*	4*
b	— Rothii		1			
b	— tenuifolia	2	2		1	
b	— proligera		1			
b	— grandiflora					2
b	Mniobryum albicans	4*	4*	4*	4	4*
b	Bryum purpurascens	2*	3*	2*	2*	1
b	— lacustre	2*	3*	1*	2*	2*
a	— Kaurini	1*				
a	— archangelicum			1*	1*	1*
u	— inclinatum	4*	4*	4*	4*	4*
a	— retusum		2*	1*		
Icel.	— islandicum		1*			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
b	Bryum calophyllum	1*				
u	— uliginosum		2*		1*	
Icel.	— Grœnlundii				1*	
b	— fallax		1*			
a	— œneum	2	1	1	1*	3*
m	— bimum	1*				
b	— affine	3*	3*	3*	3*	3*
b	— cirratum	2*	2*	3*	2*	1*
u	— intermedium		1*			1*
b	— pallescens	3*	3*	3*	3*	4*
a	— subrotundum					1*
u	— capillare	1	1		1	2*
u	— cæspiticium	2*	2*			1*
a	— comense		1			
u	— argenteum	3	3	3	3	3
a	— neodamense var. ovatum	1				
b	— Duvalii	4*	4*	4	4	4
u	— pallens	3	3	3	3*	4*
u	— ventricosum	4*	4*	4*	4*	4*
a	— arcticum	3*	3*	3*	3*	2*
u	— pendulum		1*		1*	2*
a	— Brownii		1*		1*	
a	— Jörgensenii					1*
m	Mnium hornum	3	2	3	3	4
a	— orthorrhynchum	4	4	4	4	4
m	— serratum		1*		2*	3*
u	— spinosum		1			
m	— undulatum					3
m	— cuspidatum		1			1
b	— medium	1				
u	— affine	4	4	4	4	4
u	— Seligeri	3	2		2	4
m	— stellare	1	1*		1	1
b	— cinclidioides	4	4	4	4	4
u	— punctatum	4*	4*	4*	4*	4*
b	— subglobosum		2*		1*	1
b	Cinclidium stygium	4*	4*	3*	3*	3*
b	Paludella squarrosa	4	4	3	3	2
b	Amblyodon dealbatus		1*			
b	Meesea trichoides	4*	4*	4*	4*	4*
u	— triquetra	3	3	2	2	2
b	Catoscopium nigritum	4*	4*	2*	4*	2*
a	Conostomum boreale	3*	3*	4*	3*	3*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	Aulacomnium palustre	4	4	4	4	4
a	— turgidum	2	2	2	1	1
u	Bartramia ityphylla	4*	4*	4*	4*	4*
b	Plagiopus Œderi	1*	1*			
u	Philonotis fontana	4*	4*	4*	4*	4*
b	— Arnellii		1		1	1
a	— seriata	2	3*	4*	2	1
b	— tomentella	4*	4*	4*	4*	4*
a	Timmia norvegica	1	1			1
b	— austriaca	4	4*	2	4	4
m	Catharinea undulata	2*	1*		3*	4*
a	Oligotrichum hercynicum	2*	2*	4*	2*	3*
a	Psilopilum lævigatum	3*	3*	3*	3*	3*
m	Pogonatum polytrichoides				2*	2*
a	— dentatum var. minus				1*	
u	— urnigerum	3*	3*	3*	3*	3*
a	Polytrichum alpinum	4*	4*	4*	4*	4*
m	— formosum				1	
b	— gracile	3*	3*	3*	3*	3*
a	— sexangulare	?	3*	4*	3*	3*
u	— piliferum	1*	2*	2*	2*	2*
u	— juniperinum	3*	3*	3*	3*	3*
b	— strictum	2	3	3	2	2
u	— commune	2	2	2	2*	2
b	— Swartzii			1		
b	— — var. nigrescens			1		
u	Diphyscium sessile	3	1*	2	3*	3*
u	Fontinalis antipyretica	3	3	3	3	3
Icel.	— islandica	1				
Icel.	— longifolia					2*
Icel.	— thulensis					1
b	— androgyna				1*	1*
m	Leucodon sciuroides	1			1	2*
u	Antitrichia curtipendula	2	2	2	3	3
m	Neckera complanata				1	2
b	Myurella julacea	4	4	4	4	4
b	— apiculata	3	3	3	3	2
b	Leskea nervosa	1				1
u	— catenulata			1		
m	Anomodon viticulosus					1
u	Pterigynandrum filiforme	4	4	4	4	4
a	Lescuræa decipiens	1		1		
a	— radicosa		1			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
b	Lescuræa filamentosa	3	3	4*	3	3
a	— Breidleri	1	2	3		1
b	— patens	1	1*	2*	2	1
b	Heterocladium squarrosulum	1	1		1	1
m	Thuidium tamariscinum					3
m	— delicatulum			1	2	3
m	— Philiberti				1	3
b	— lanatum	4*	4*	2*	2*	1*
a	Orthothecium rufescens				1	
a	— intricatum		1			2
a	— chryseum	4	4	2	2	
m	Cylindrothecium concinnum		1			1
u	Climacium dendroides	4*	4	4	4	4
m	Isothecium myurum				1	2
b	— tenuinerve	1		1	3	3
u	Homalothecium sericeum	4	4	4	4	4*
m	Camptothecium lutescens	2	2	2	3	3
b	— nitens	4*	4*	4*	4*	3*
u	Brachythecium Mildeanum	1			1	
u	— salebrosum	2	2	2	2	2*
a	— collinum				1	
Icel.	— longifolium					1*
u	— populeum					1*
u	— velutinum					2*
a	— glaciale		1	1	1	
b	— reflexum	3*	3*	3*	3*	3*
u	— glareosum	1	1		1	
u	— albicans	3	3	3	3	3
b	— erythrorrhizon		1		1	
b	— rivulare	4	4	4	4	4
b	— latifolium		1			
m	Scleropodium purum					3
m	Eurhynchium strigosum				1	
m	— — var. præcox		1		1	1
a	— diversifolium		1			
a	— cirrosum				1	
m	— piliferum				2	3
m	— Swartzii					3
m	— Stockesii					2
m	Rhynchostegium murale					1*
m	— rusciforme		1	1	2	3*
b	— — v. atlanticum		2		1	2
m	Thamnium alopecurum				1	3

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	Plagiothecium silvaticum		1			1
u	— Rœseanum	3	3	3	3	3
u	— denticulatum		2	1	1	1
b	— pulchellum	3*	3*	3*	3*	3*
m	— depressum					1
m	— elegans					1
a	Amblystegium Sprucei	3	3	3	3	3
m	— fluviatile					1
m	— serpens		1*	1*		1*
m	— Juratzkanum		1*			1*
b	— littorale		1		1	
b	— compactum				1	1
b	— salinum					1
m	— trichopodium		1			
m	Hypnum Sommerfeltii		1			1
u	— chrysophyllum	1	1		1	1
u	— protensum	2	1		2	
u	— stellatum	4*	4*	4*	4*	4*
b	— polygamum	4*	4*	3*	4*	3*
u	— intermedium	?	3	?	?	?
b	— revolvens	4*	4*	4*	4*	4*
u	— uncinatum	4*	4*	4*	4*	4*
m	— Sendtneri		1			
b	— Kneiffii	3	3*	2	2	2
u	— exannulatum	4*	4*	4*	4*	3*
a	— — var. Rotæ	2		1	1	
u	— fluitans		1			1
a	— — var. falcatum			2*		
u	— filicinum	4*	3*	4*	4*	4*
a	— curvicaule	2*			1	
b	— decipiens	4	4*		1	
m	— commutatum	2	2	2	2	3*
b	— falcatum	4*	4*	4	4	4*
m	— molluscum	1			3	4*
b	— imponens	1			1	
a	— Bambergeri				1	
a	— revolutum	4	4	4	4	4*
u	— cupressiforme	2	2		3	4*
a	— hamulosum	1		1	2	2
a	— callichroum	1		3*	2	3
u	— Lindbergii	4	4	4	4	4
u	— palustre	1*	2*		2*	3*
a	— arcticum			1*	1*	

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	Hypnum alpestre	3*	3*	3*	2*	2*
a	— alpinum	1*	3*	3*		
a	— ochraceum	4	4	4	4	4
u	— cordifolium		1	1*		
b	— Richardsonii	2*	2*	1	1	1
b	— giganteum	4*	4*	4*	4*	4*
u	— stramineum	4	4*	4	4	4
a	— sarmentosum	3	3*	3*	3	3
b	— trifarium	1	1			
a	— turgescens	1	1			1
u	Acrocladium cuspidatum	4*	4*	4*	4*	4*
u	Scorpidium scorpioides	4	4	4	4	3
u	Hylocomium proliferum	4	4	4	4	4
b	— pyrenaicum					1
u	— parietinum	2		3	3	3
u	— loreum			2	3	3*
u	— triquetrum	2	1	2	3	3
u	— squarrosum	4	4	4	4	4
b	— rugosum	3	3	3	3	3

Of the 93 Hepaticæ, 20 Sphagna and 326 Musci veri found in Iceland, 7 Hepaticæ, 3 Sphagna and 4 Musci veri (besides 3 varieties) have been found only on warm soil. The other 425 species (87 Hepaticæ, 17 Sphagna and 322 Musci veri) enumerated in the above table can be arranged according to frequency in the following groups (Table V): —

a. Dominant or very common species, the frequency of which is expressed by the figure 4 in all parts of Iceland or by 3 in only a few parts.

b. Frequent species, the frequency of which is expressed by the figure 3 in the whole, or at any rate in the greater part, of Iceland.

c. Species of which the frequency is expressed by the figures 1 à 2, or which have a higher degree of frequency only in a single district of Iceland.

Table V.

	Group a	Group b	Group c
Hepaticæ	23	14	49
Sphagna	1	3	13
Musci veri	64	82	176
Total...	88	99	238
	20.7 %	23.5 %	55.8 %

Iceland, according to the climatic conditions, may be divided into 5 districts, which division, also as regards the Land vegetation, coincides well with that employed by Helgi Jónsson (1912, p. 5) for the Marine vegetation along the coasts.

East Iceland, from Eystri Horn in the South-east to Langanes in the North-east.

North Iceland, from Langanes to Cape Horn in the North-west.

North-west Iceland, from Cape Horn to Látrabjarg.

West Iceland, from Látrabjarg to Reykjanes.

South Iceland, from the western point of the peninsula of Reykjanes to Eystri Horn.

The boundary lines between these districts are in most places formed by ridges or high-lying mountain plateaus. In the South-east, Lónsheidi (height about 400 metres) and Hofsjökul form the boundary between South and East Iceland. West Iceland is separated from South Iceland by the mountain-chain which stretches throughout the peninsula of Reykjanes, the lofty mountain of Hengill, the lake of Thingvalla and the mountains situated north of a line drawn from Thingvellir to Geysir. Between North and East Iceland there is no sharp boundary line, either as regards climate or geography. South-east Iceland (from Seydisfjördur southwards) has a very damp climate with many foggy days (near Berufjördur on an average 171 annually), while the western part of North Iceland (the districts about Eyjafjördur, Skagafjördur and Hunaflói) has a greater difference between the summer and the winter temperature, considerably less precipitation and comparatively few foggy days. North-west Iceland, which comprises the country around the deep, narrow

fjords which open out towards the north-west, lies rather isolated, separated as it is from North and West Iceland by Jökulls and lofty mountain-ridges. The boundary between North and West Iceland is rather undefined. Several species which are common in West Iceland, but rare in or absent from North Iceland, are met with right in around Hunaflói. Here the range of hills east of Blóndudalur appears to form a natural boundary, since *Camptothecium lutescens* and *Rhacomitrium heterostichum*, for instance, have not been found east of this line, whilst other species common in North Iceland, for instance *Orthothecium chryseum*, *Hypnum decipiens* and *Thuidium lanatum*, are rare west of it.

Of the 87 Hepaticæ, 17 Sphagna and 322 Musci veri enumerated in Table II, 30 Hepaticæ, 4 Sphagna and 108 Musci veri (or collectively 33 °/₀), are almost equally frequent in all the districts of Iceland, the frequency being (with a few exceptions) 3—4. The rest of the species can be grouped as follows: —

1. Species with a mainly Southern distribution.
2. » » » » Northern and Eastern distribution.
3. » » » » Western distribution.
4. Species which occur sporadically in several of the districts of Iceland.

1. Species with a mainly Southern Distribution.

a. Found only in South Iceland (the figure denotes frequency).

Meridional.

Reboulia hemisphærica	3
Fegatella conica	4
Fossombronia Dumortieri	1
Aneura multifida	1
Jamesoniella autumnalis	1
Lophozia excisa	1
Lophocolea cuspidata	1
Lepidozia setacea	1
Weisia viridula	1
Tortula muralis	1
— mucronifolia	1
Hedwigia albicans	1
Orthotrichum anomalum	1
— saxatile	1
— cupulatum	1
Mnium undulatum	3
Anomodon viticulosus	1
Thuidium tamariscinum	3
Scleropodium purum	3
Eurhynchium Swartzii	3
— Stockesii	2
Rhynchostegium murale	1
Plagiothecium elegans	1
— depressum	1

Boreal.

Haplozia riparia	3
Sphagnum compactum	1
Pohlia grandiflora	2
Amblystegium salinum	1
Hylocomium pyrenaicum	1

Alpine.

Scapania Bartlingii	1
Dicranum fulvellum	3
Bryoxiphium norvegicum	3
Tortula obtusifolia	1

Anomobryum concinnum 1
Bryum Jörgensenii 1

Ubiquists.

Brachythecium populeum 1
— velutinum 1

Icelandic species.

Brachythecium longipilum 1
Fontinalis thulensis 1
— longifolia 2

b. Found in South Iceland and in the most nearly adjacent parts of West and East Iceland.

	S.	W.	E.
Meridional.			
Marsupella Funckii	1		1
Frullania fragilifolia	1	1	
Lejeunea serpyllifolia	3	1	
Sphagnum papillosum	2	2	
Weissia crispata	1	1	
Barbula unguiculata var. cuspidata	1	1	
Trichostomum littorale	1	1	
Leucodon sciuroides	2	1	
Isothecium myurum	2	1	
Eurhynchium piliferum	3	2	
Hypnum molluscum	4	3	1
Thuidium Philiberti	3	1	
Boreal.			
Fontinalis androgyna	1	1	
Alpine.			
Dicranum Andersonii	3		1
Ubiquists.			
Grimmia patens		1	1

c. Most frequent in South Iceland, rarer in the other districts of Iceland.

	S.	W.	NW.	N.	E.
Meridional.					
Radula complanata	3	3		1	3
Madotheca Cordæana	4	3		2	2
Barbula cylindrica	3	1		1	
Mnium hornum	4	3	2	2	3
— serratum	3	2		1	
Catharinea undulata	4	3		1	2
Neckera complanata	2	1			
Thuidium delicatulum	3	2	1		
Rhynchostegium rusciforme	3	2	1	1	
Thamnium alopecurum	3	1			
Hypnum commutatum	3	2	2	2	2
Boreal.					
Sphagnum medium	2	1	1		
Hymenostylium curvirostre	3	1		1	
Grimmia torquata	4	3	2	1	2
Plagiobryum Zierii	2	2	1	1	2
Alpine.					
Bryum œneum	3	1	1	1	2
Ubiquists.					
Sphagnum subnitens	2	2	1		
Bryum capillare	2	1		1	1
— pendulum	2	1		1	
Mnium Seligeri	4	2		2	3
Antitrichia curtipendula	3	3	2	2	2
Hypnum palustre	3	2		2	1
— cupressiforme	4	3		2	2
Hylocomium loreum	3	3	2		
— triquetrum	3	3	2	1	2

2. Species with a mainly Northern Distribution.

With the exception of the southernmost part of East Iceland — almost as far as Djupivogur — and the westernmost part of North Iceland — as far as Blóndudalur — there is a very great

resemblance between the Bryophyte vegetation of East and North Iceland, therefore they will partially be mentioned collectively in the following lists.

a. Found only in North Iceland.

Meridional.

Sphagnum angustifolium	1
Leptodontium flexifolium	1
Amblystegium trichopodium	1

Boreal.

Haplozia pumila	1
Pohlia proligera	1
— Rothii	1
Bryum fallax	1
Mnium spinosum	1
Amblyodon dealbatus	1
Brachythecium latifolium	1

Alpine.

Sauteria alpina	1
Scapania remota	1
Weisia Wimmeriana	1
Dicranoweisia compacta	1
Pottia latifolia	1
Desmatodon cernuus	1
Bryum comense	1
Pohlia Ludwigii	1
Eurhynchium diversifolium	1
Lescuræa rigescens	1

Icelandic.

Bryum islandicum	1

b. Found only in East Iceland.

Meridional.

Bryum bimum	1

Boreal.

Leptoscyphus anomalus	1
Bryum calophyllum	1

Alpine.

Ditrichum nivale	1
Bryum neodamense var. ovatum	1
— Kaurini	1
Grimmia incurva	1

Ubiquists.

Cynodontium polycarpum	1
Tortella inclinata	1

Icelandic.

Fontinalis islandica	1

c. Found only in North and East Iceland.

Meridional.

	N.	E.
Diplophyllum obtusifolium	1	1

Boreal.

	N.	E.
Schistidium confertum	2	1
Grimmia ovata	2	2
Plagiopus Œderi	1	1
Hypnum trifarium	1	1

Alpine.

	N.	E.
Orthotrichum Killiasii	1	1

d. Most widely distributed in East and North Iceland.

Boreal.

	E.	N.	NW.	W.	S.
Dicranum congestum	4	4	?	3	2
Distichium inclinatum	1	2	1		
Dissodon splachnoides	1	4	3	1	1
Pohlia tenuifolia	2	2		1	
Bryum purpurascens	2	3	2	2	1
— lacustre	2	3	1	2	2
Paludella squarrosa	4	4	3	3	2

	E.	N.	NW.	W.	S.
Cinclidium stygium	4	4	3	3	3
Thuidium lanatum	4	4	2	2	1
Orthothecium chryseum	4	4	2	2	
Hypnum decipiens	4	4		1	
— Richardsonii	2	2		1	
Alpine.					
Aulacomnium turgidum	2	2	2	1	1
Ubiquists.					
Meesea triquetra	3	3	2	2	2

3. Species with a mainly Western Distribution.

a. Found only in North-west Iceland.

Boreal.	
Haplozia sphærocarpa	1
Polytrichum Swartzii	1
— var. nigrescens	1
Alpine.	
Gymnomitrium revolutum	1
Sphenolobus politus	1
Cephalozia ambigua	1
Tortula aciphylla	1
Hypnum fluitans var. falcatum	2
Ubiquists.	
Marsupella aquatica	1
Gymnocolea inflata	1
Sphagnum Gravetii	1
— riparium	3
Leskea catenulata	1

b. Found only in West Iceland.

Meridional.	
Trematodon ambiguus	1
Polytrichum formosum	1
Pogonatum polytrichoides	2
Alpine.	
Plagiobryum demissum	1
Pohlia polymorpha	1
Pogonatum dentatum var. minus	1
Ubiquists.	
Fissidens decipiens	1
Encalypta contorta	1

c. Most widely distributed in North-west Iceland.

	E.	N.	NW.	W.	S.
Boreal.					
Lophozia Flœrckei			4	2	
Harpanthus Flotowianus	1	1	4	2	
Scapania uliginosa	1		3		
Dicranella squarrosa	2	2	4	2	1
Bryum cirratum	2	2	3	2	1
Alpine.					
Pleuroclada albescens	3	3	4	2	2
Pohlia cucullata		1	2		
Philonotis seriata	2	3	4	2	1
Oligotrichum hercynicum	2	2	4	2	3
Polytrichum sexangulare	3	2	4	3	3
Lescuræa Breidleri	1	2	3		1
Ubiquists.					
Dicranum majus			3	1	
— fuscescens			4	1	
Pohlia nutans	1	1	3	1	2

d. Most widely distributed in the western part of Iceland.

	E.	N.	NW.	W.	S.
Ubiquists.					
Dicranella cerviculata			1	2	2
Boreal.					
Dicranum Blyttii	1	1	3	3	3
Dicranum elongatum		2	2	2	
Isothecium tenuinerve			1	3	3
Meridional.					
Camptothecium lutescens	2	2	2	3	3
Barbula fallax				1	1

Table VI. Collective Survey of the Number of Species in the different Districts of Iceland.

Plant-geographical character	m		b		a		u		Number of Species
Frequency	1-2	3-4	1-2	3-4	1-2	3-4	1-2	3-4	
South Iceland.............	39	16	31	41	30	36	23	75	291
Found only in South Iceland	26	9	5	1	4	3	3		51
East Iceland..............	11	4	26	51	32	30	30	68	252
Found only in East Iceland	1		2		4		2		9
North Iceland.............	23	2	33	50	43	30	38	68	287
Found only in North Iceland	3		7		10				20
Found only in N. and E. Iceland.................	1		4		1				6
North-west Iceland........	7	3	19	49	27	31	25	61	222
Found only in North-west Iceland.................			3		5		4	1	13
West Iceland..............	25	8	37	48	30	25	33	76	282
Found only in West Iceland	3				3		2		8

By comparing the Tables and Lists of species contained in the present section it is seen that: —

The Meridional species belong mainly to the southern part of Iceland, in the south-western part of which they arrive at their maximum, both as regards number and frequency, and from thence decrease in number and frequency towards north-west and east. In south-east Iceland there is a tolerably sharp limit for their distribution, whilst a great number of species are to be found — but with decreasing frequency — even throughout the whole of West Iceland. The respective percentages of the entire number of species are as follows: — South Iceland 19 %; East Iceland 6 %; North Iceland 9 %; North-west Iceland 5 % and West Iceland 12 %. A comparatively great number of species have been found in a single locality, or in a few localities, in North Iceland, especially around Eyjafjördur and eastwards in the valleys towards Mývatn, which may probably be due to the higher summer temperature of these districts.

The Boreal Group, over the whole of Iceland — with the exception of South Iceland — constitutes the same percentage of the vegetation (S. Icel. 24 %; E. Icel. 30 %; N. Icel. 29 %; NW. Icel. 31 % and W. Icel. 30 %), and the great majority of the species belong to those which are common everywhere (56 species are common to all the districts of Iceland, with a frequency of 3—4, corresponding to about 60—75 %).

The Alpine Group likewise shows almost the same percentage in all the districts (S. Icel. 23 %: E. Icel. 25 %: N. Icel. 26 %: NW. Icel. 26 % and W. Icel. 20 %) of which about half the number (some 30 species) are common to all the districts.

The Ubiquitous Group comprises chiefly species which have a great distribution in all parts of Iceland (S. Icel. 34 %: E. Icel. 39 %; N. Icel. 38 %; NW. Icel. 39 % and W. Icel. 38 %), 73 of which (67—85 %) are common to all the districts, with a frequency of 3—4.

The composition of the vegetation as regards percentage is thus very nearly the same everywhere as regards the three last groups, whilst, with regard to the meridional species, the country may be divided into a north-eastern and a south-western part.

The North-eastern part comprises East and North Iceland as far as Blóndudalur. The meridional species play a very slight rôle in the vegetation here. Two species only, *Metzgeria furcata* and *Rhacomitrium aciculare*, are common everywhere in this part, and five species, viz. *Radula complanata*, *Madotheca Cordæana*, *Catharinea undulata*, *Mnium hornum* and *Hypnum commutatum*, are somewhat frequent in East Iceland, but are absent from, or are rare in, North Iceland.

Some few, principally Boreal and Alpine species, are characteristic of North and East Iceland.

Hypnum decipiens is very common from Seydisfjördur to Blóndudalur, but is absent from, or is rare in, the other parts of Iceland.

Orthothecium chryseum is one of the most commonly occurring species in the whole of East and North Iceland, but is absent from South Iceland, and is rather rare west of Hunaflói.

Grimmia ovata has been found only in East and North Iceland. *Philonotis tomentella* is very common in meadow-ground in North and East Iceland, from Seydisfjördur; but is less frequent on damp rocks in other parts of Iceland.

Cinclidium stygium, Meesea triquetra, Paludella squarrosa, Thuidium lanatum, Hypnum exannulatum, H. Richardsonii, H. sarmentosum and *H. alpestre* occur far more abundantly in the northern half of Iceland than in the southern, and are often the most abundant constituents of the vegetation.

Dicranum congestum, which is one of the most commonly occurring species in North and East Iceland and occur there in numerous forms, is far more rare in South and West Iceland, and is evidently absent from North-west Iceland.

A rather considerable number of species, which are most frequent in South and West Iceland, decrease in frequency throughout East Iceland, and are absent from, or are rarer in, North Iceland, for instance *Scapania dentata, Anœctangium compactum, Grimmia torquata, Rhacomitrium heterostichum, R. fasciculare, Amphidium Mougeottii, Mnium Seligeri, Diphyscium sessile, Hypnum filicinum, H. cupressiforme, Hylocomium parietinum* and *H. triquetrum*.

South Iceland. The vegetation is primarily characterized by the presence of numerous meridional species, of which those with a frequency of 3—4 constitute an essential part of the moss-covering.

Fegatella conica and *Reboulia hemisphærica* in company with *Preissia commutata* and *Marchantia polymorpha* form special *Marchantiaceæ*-associations on damp shady tuff-faces. *Lejeunea cavifolia, Madotheca Cardœana, Barbula cylindrica, Mnium serratum, M. undulatum, Catharinea undulata, Thuidium tamariscinum, T. delicatulum, T. Philibertii, Eurhynchium piliferum, E. Swartzii, Rhynchostegium rusciforme, Scleropodium purum, Thamnium alopecurum, Hypnum molluscum* and *H. commutatum* are the most frequently occurring species in SW. Iceland. Of the boreal Bryophyta *Haplozia riparia, Hymenostylium curvirostre, Grimmia torquata* and *Plagiobryum Zierii* are most widely distributed in South Iceland; but this is no doubt chiefly due to the fact that a suitable substratum (tuff) abounds.

The Alpine species *Dicranum Andersonii, D. fulvellum* and *Bryoxiphium norvegicum* are common in the tuff districts of South Iceland, but have not been found in other parts of the country.

Several ubiquists occur more frequently and abundantly in South Iceland than in the other districts, for instance *Mnium Seligeri, Antitrichia curtipendula, Hypnum palustre, H. cupressiforme, Hylocomium loreum, H. triquetrum* and *H. parietinum*. These species ascend only exceptionally above the limit of the birch.

The difference in the climate is also apparent from the fact that species, which in North and East Iceland are common as far down as the low land, in South Iceland are first met with in abundance at a higher altitude. This is for instance the case with *Schistidium rivulare, Oncophorus Wahlenbergii, O. virens* and *Dicranum congestum* which are not common until at a height of 200—300 metres. The Bryophyte vegetation in the higher-lying bogs (200—500 metres) also corresponds closely with the bog vegetation of the lowlands of North and East Iceland, while the bog vegetation of South Iceland differs somewhat considerably in character (p. 561).

North-west Iceland. The Bryophyte vegetation differs in several points from that of the other districts. From a narrow belt of coastal land the country rises abruptly to a height of about 500 metres, so that there is only room for the boggy tracts, so common in the other districts of Iceland, in those valleys which, from the head of the fjords, ascend towards the high land. Here the number of species is essentially smaller than in the other districts of Iceland, since many of the common species, as well as of the rare ones, are absent, on the other hand, however, there are some few species which are widely distributed in North-west Iceland, but are absent from, or rarer in the other districts. This, among others, is the case with regard to several of the species belonging to the heath formation.

Dicranum fuscescens, D. majus and *D. molle* are very common in NW. Iceland and, in association with other species (especially Hepaticæ), form *Dicranum* heaths (p. 591): a formation which is otherwise rare in Iceland. *Pohlia nutans* and *Bryum cirratum* are also common, especially in the birch coppices. *Polytrichum piliferum* is tolerably frequent and has been found in fruit in several places.

Lophozia Flœrkei is very common as far upwards as about 500 metres above sea-level. It has, however, only been found in a lava-field in SW. Iceland.

There are also several hygrophilous species which are characteristic of NW. Iceland: *Sphagnum squarrosum* is frequent on damp slopes and *S. riparium* is rather common in pools. On inundated ground *Scapania uliginosa, S. paludosa, Harpanthus Flotowianus* and *Philonotis seriata* are very common and often form — either separately or collectively — the bulk of the vegetation. *Hypnum fluitans* var. *falcatum* occurred abundantly north of Isafjördur.

The rocky flat is very widely extended in NW. Iceland, since it comprises all the flats and plateaus above the mountain slopes, and on the north side of the mountains descends as far downwards as to the sea-level. Several rocky-flat plants are therefore more widely distributed here than in the other districts of Iceland. *Oligotrichum hercynicum*, *Rhacomitrium sudeticum*, *Conostomum boreale*, *Lescurœa Breidleri*, *Gymnomitrium concinnatum* and *Pleuroclada albescens* are very common. *Sphenolobus politus*, *Haplozia sphœrocarpa*, *Gymnomitrium revolutum* and *G. varians* have been found only on the rocky flats of NW. Iceland.

Lescurœa filamentosa is very common and found fruiting on detached blocks and on rocks, and *L. patens* is also frequent and likewise sets fruit.

Some few species, which are widely distributed elsewhere in Iceland, are absent here, for instance *Scapania dentata*, *Radula complanata*, *Gymnostomum rupestre*, *Campylopus Schimperi*, *Sœlania cœsia*, *Mnium Seligeri*, *Hypnum cupressiforme* and *Hypnum palustre*, whilst others are rare, for instance *Preissia commutata*, *Leptobryum pyriforme*, *Catoscopium nigritum*, *Timmia austriaca* and *Hypnum falcatum*. The comparatively abundant occurrence of species of *Sphagnum*, and the lesser frequency of the last-mentioned lime-loving species, appear to indicate that the soil here is less calcareous than in the other districts of Iceland.

The Bryophyte vegetation of NW. Iceland has, on the whole, a more decidedly xerophilous and Arctic character than that of the rest of Iceland.

West Iceland has, with the exception of the southern part as far as Borgarfjördur, been very superficially investigated and, apart from a few scattered collections made by Helgi Jónsson, especially in Búdahraun on Snæfellsnes, and my own collections near Stýkkisholmur, the whole stretch of coast north of Hvalfjördur and around Breidifjördur is, from a bryological point of view, quite unknown.

Several of the species characteristic of South Iceland occur here also, partially decreasing in frequency throughout West Iceland, for instance *Thuidium delicatulum*, *Hylocomium loreum*, *Eurhynchium piliferum* and (in the South-west) *Madotheca Cordœana*. Some species have a decidedly westerly distribution in Iceland, being of almost equal frequency in West and South-west Iceland and a few also in

the North-west, whilst they are absent from, or rare in, the other districts of the country. To this group belong: *Dicranella cerviculata, Dicranum Blyttii, D. elongatum* (western part of N. Iceland around Hunaflói; NW. and W. Iceland), *Ditrichum homomallum* (common in the South-west), *Isothecium tenuinerve, Rhynchostegium rusciforme, Hypnum hamulosum* and *Hylocomium parietinum.* Finally, *Diplophyllum albicans* is characteristic of all the lava-fields of West and South-west Iceland.

BIBLIOGRAPHY.

As to the older records respecting the Flora of Iceland (Zoëga, Gliemann, Hooker, Hjaltalin, Vahl, Hornemann, Lindsay, Caroll and others) reference may be made to the full mention of these authors by Grönlund in Botan. Tidsskr., Vol. 4, 1870—71, p. 147 and Vol. 7 (2. R., 3. Bd.), 1873, p. 1.

Arnell, H. W. (1892), Lebermoosstudien im nördlichen Norwegen. Jönköping.

Arnell, H. W. and Jensen, C. (1907), Die Moose des Sarekgebietes. Naturw. Unters. des Sarekgebietes in Schwed.-Lappland, III, Stockholm.

Braithwaite, The British Moss-Flora. London, vol. I, 1880—1887; vol. II, 1888—1895; vol. III, 1903—09.

Flora danica. Icones plantarum in regnis Daniae et Norvegiae nascentium ad illustrandam Floram danicam ediderunt G. C. Oeder, O. F. Müller, M. Vahl, J. W. Hornemann, S. Drejer, F. M. Liebmann, Joh. Lange, Fasc. 1—50. Hafniae, 1761—1880.

Grönlund, Chr. (1870—71), Bidrag til Oplysning om Islands Flora. Bot. Tidsskr., Bd. 4, pp. 147—172.

— (1873), Bidrag til Oplysning om Islands Flora. 2. Hepaticæ og Musci. Bot. Tidsskr., Bd. 7, pp. 1—26.

— (1877), Islandske Naturforhold med særligt Hensyn til Mosvæxtens Betydning for Landskabet. Tidsskr. for populære Fremst. af Naturvidensk., 5 R., IV, pp. 321—356.

— (1881), Islands Flora. Kjøbenhavn.

— (1884), Karakteristik af Plantevæxten paa Island sammenlignet med Floraen i flere andre Lande. Den Naturhistoriske Forenings Festskrift, Nr. 1. Kjøbenhavn, pp. 107—145.

— (1885), Afsluttende Bidrag til Oplysning om Islands Flora. Musci. Hepaticae. Lichenes. Bot. Tidsskr. XIV, pp. 159—217.

— (1895), Tillæg til Islands Kryptogamflora, indeholdende Lichenes, Hepaticae og Musci. Bot. Tidsskr. XX, pp. 90—115.

Hagen, I. (1899—1901), Musci Norwegiae Borealis. Tromsö Museums Aarshefter 21—22.

— Forarbejder til en norsk Lövmosflora I—XX. Det Kgl. Norske Videnskabers Selskabs Skrifter, Trondhjem 1908—1915.

Jensen, C. (1897), Beretning om en Rejse til Færöerne i 1896. Bot. Tidsskr. XXI, pp. 157—219.

— (1901), Bryophyta. Botany of the Færöes, vol. 1, Copenhagen, pp. 120—197.

— (1915), Danmarks Mosser. I. Hepaticales. Anthocerotales. Sphagnales. København og Kristiania.

Jónsson, Helgi (1895), Studier over Ost-Islands Vegetation. Bot. Tidsskr. XX, pp. 17—89.

— (1899), Floraen paa Snæfellsnes og Omegn. Bot. Tidsskr. XXII, pp. 169—207.

Jónsson, Helgi (1900), Vegetationen paa Snæfellsnes. Vidensk. Medd. fra den Naturhist. Forening i Kjøbenhavn, pp. 15—97.

— (1905), Vegetationen i Sydisland. Bot. Tidsskr. XXVII, pp. 1—82.

— (1912), The Marine Algal Vegetation. The Botany of Iceland, Part 1, 2. Copenhagen and London.

Limpricht, K. G., Die Laubmoose in Rabenhorst Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Leipzig 1890—1904.

Loeske, Leopold (1905—6), Kritische Bemerkungen über einige Formen von Philonotis. — Hedwigia, Bd. 45, p. 100.

— (1905—6), Kritische Übersicht der europäischen Philonotis-Arten. Hedwigia, Bd. 45, p. 145.

— (1911), Revision einiger Amblystegium aus dem Herbare Limpricht. Ung. botan. Blätter, pp. 272—97.

Müller, K., Die Lebermoose in Rabenhorsts Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Leipzig 1909—1915.

Ostenfeld, C. H. (1899), Skildringer af Vegetationen paa Island. Bot. Tidsskr. XXII, pp. 227—253.

Stefánsson, St. (1896), Bemærkninger til Chr. Grönlund: Tillæg til Islands Kryptogamflora indeholdende Lichenes, Musci, Hepaticae. Bot. Tidsskr. XX, pp. 399—402.

Thorodsson, Th. (1914), An Account of the Physical Geography of Iceland, with Special Reference to the Plant-Life. The Botany of Iceland, Part I, 2. Copenhagen and London.

Warming, Eug. (1884), Om Grönlands Vegetation. Medd. om Grönland, XII, 245 pp.

— (1895), Plantesamfund. Grundtræk af den ökologiske Plantegeografi. Kjobenhavn.

Warnstorff, C., Kryptogamenflora der Mark Brandenburg, Bd. I, Moose. 1901—1903.

Winther (1910), Beiträge zur Kentniss der Pohlia commutata, P. gracilis, P. cucullata und P. carinata. Hedwigia 49, p. 54.

LIST OF THE SPECIES.

ERRATA.

P. 429 l. 7 add Geysir!
- 434 - 1 should read "I. Musci veri".
- 438 - 25 for "elongatum" read "elongatus".
- 463 - 10 from bottom for "Weissia" read "Weisia".
- 471 - 6 for "Wiinsted" read "Wiinstedt".
- 473 - 24 for "*tenuifolia*" read "*grandiflora*".
- 588 - 19 for "Associations" read "Formations".

CONTENTS.

THE BOTANY

OF

ICELAND

EDITED

BY

L. KOLDERUP ROSENVINGE

PH. D.

AND

EUG. WARMING

PH. D., SC. D.

VOL. I

WITH ONE PLATE AND 82 FIGURES IN THE TEXT

COPENHAGEN

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CONTENTS

Særtryk af Botanisk Tidsskrift. 37. Binds 4. Hefte. 1922.

On a new species of Furcraea Vent. from Nicaragua.

By

Johs. Boye Petersen.

(With Plate IV.)

In the year 1848 an Agave-like plant was introduced into the Botanical Garden of Copenhagen by A. S. Ørsted, who had collected it in Nicaragua. During the time the plant was cultivated in the hot-house as *Agave* sp., it did not flower until 1921 and therefore a determination was impossible. Prof. W. Trelease, paying a visit to Copenhagen in 1912, critically revised the collection of *Agave* in the Botanical Garden and also saw the specimen mentioned. He was, however, unable to name the sterile plant, but supposed that it belonged to an undescribed species.

In the year 1921 it was observed that the specimen was about to flower and the development of the inflorescence was, of course, followed with interest. In December a scape with a panicle in all about 3 m high shot up. When trying to determine the flowering specimen I quickly found that it did not belong to the genus *Agave* but to *Furcraea* Vent., and moreover I discovered that it could not rightly be referred to any described species af *Furcraea* judging from the material, to which I have had access, viz. literature, living specimens in our hot-houses, dried specimens and specimens in alcohol in the museum.

Unfortunately most descriptions of the species of *Furcraea* are more or less incomplete, and some species are not figured. It must be regretted that Drummond, who in 1907 wrote on the genus, has not given new descriptions of all species adopted by him, as he certainly has had an unusually good material at his disposal, although, as he says himself, it was deficient as to certain points.

Arbejder fra den botaniske Have i København. Nr. 98.

Notwithstanding these insufficient descriptions I feel convinced that our plant represents an undescribed species. It is one of the smaller species of the genus, charcterised by its very compressed bulbils, small flowers and geminate spines in the margins of the leaves as in *F. geminispina.* I therefore propose to describe it as a new species and name it:

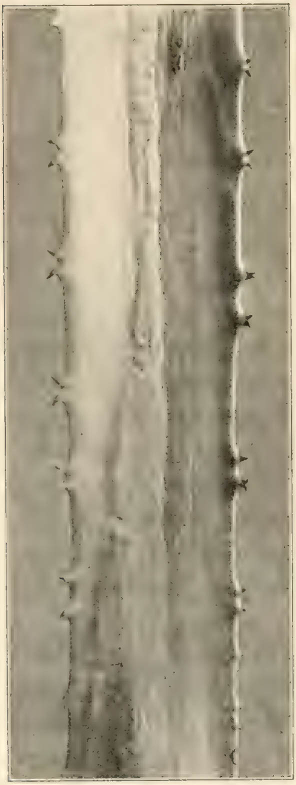


Fig. 1. Part of the lower portion of a leaf showing marginal characters. Nat. size.

Furcraea stratiotes Boye P. n. sp.

F. caule brevissimo, foliis circiter 50 dense rosulatis, 35—53 cm longis, 3,5—5 cm latis, utrinque glabris lævibusque, margine spinis rigidis geminis instructis; scapo cum panicula 2,8 m alto, floribus pendulis albidis pedicellatis parvis, 22 mm longis, bulbillis numerosis valde compressis; fructu ignoto.

Specimen in Nicaragua lectum 1848 (A. S. Ørsted) et in hortum botanicum Hauniense introductum et cultum. Fl. 1921.

Stem lacking or very short; leaves (about 50) in a rosette, with a base 5—6 cm broad, 3 cm thick; above the base contracted to 2,5—3 cm, linear-lanceolate, 35—53 cm long, 3,5—5 cm broad at the middle, long-acuminate, the apex with a small whitish mucro, not a pungent spine, both surfaces smooth and glabrous, margin with double brown horny spines, not more than 2—3 mm long, with a distance of 1—3 cm between two pairs (Fig. 1); simple spines are to be found near the tip of the leaf only.

Scape 2 m high, at the base 2,5 cm, at the middle 2 cm, and just below the panicle 1,3 cm broad, finely furrowed.

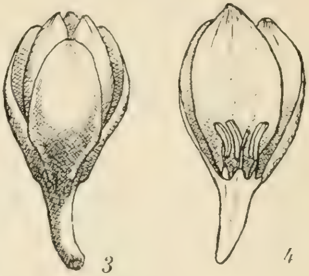
The lower bracts of the scape 2 cm broad, 6 cm long, obtuse, their margins minutely denticulate (Pl. IV, fig. 2), the upper ones smaller, acuminate, entire.

Panicle (Pl. IV, figs. 1, 3) about 80 cm long, thrice branched;



Fig. 2. Branch of the panicle with numerous bulbils and a flower ($\times$ 2/3).

the single branches with small brown membranous bracts. Flowers solitary, with 1—2 bulbils (Fig. 2). These are of very varying sizes, the largest 3,5 cm long, 1,5 cm broad, very compressed, with 3—5 visible leaves, not densely united like a bulb (Fig. 6, 7). Bulbils also are developed in the axils of the upper bracts of the scape below the inflorescence. The flowers on pedicels 1/2—1 cm long, cernuous, with 6 cream-coloured perianth-segments and of a faint scent. The outer segments 1,4 cm long, 0,6 cm broad, the inner a little broader (Fig. 3, 4). Stamens much shorter than the perianth-segments. Filaments 2,5 mm long, at the base 1 mm thick, upwards subulate. Anthers 4 mm long, 1,5 mm thick, versatile (Fig. 5). Ovary 8 mm long, 2 mm thick, its transverse section obtuse triangular. Style 5 mm long, thickened at the base. The flowers all barren; the fruit therefore unknown.



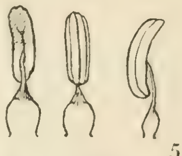


Fig. 3. Flower. ($\times$ 1 1/2).
Fig. 4. Longitudinal section of a flower ($\times$ 1 1/2).
Fig. 5. Stamens; back-view, front-view, and side-view ($\times$ 3). K. Wiinstedt del.

One of the most striking peculiarities of the plant in question, I should think, is the very compressed bulbils, similar to the flower-buds with the two green bracts of *Stratiotes aloides* (hence the name of the species). I tried therefore, to compare these bulbils with those of other species of *Furcraea* allied to our species, but I found that in most descriptions given the bulbils were not mentioned at all. Only

in the descriptions and illustrations of the following species I find some information as to the shape of the bulbils.

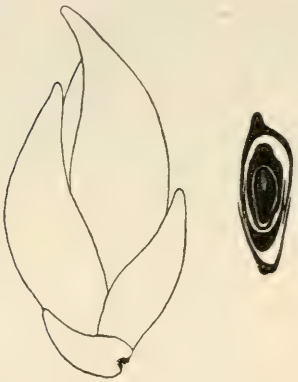


Fig. 6. Bulbil and a transverse section of it. (× 2).



Fig. 7. Front and side-view of bulbil. (× 1½). K. Wiinstedt del.

Furcraea cubensis Jacquin 1763 p. 100, tab. 175, fig. 28 shows a terete, bulb-like bulbil, and in the text it is also described in this manner.

— *Cabuja* Trelease 1910 Taf. 37. Terete, bulb-like bulbils.

— *elegans* Todaro. In the description in Hortus Panormitanus nothing is said about the shape of the bulbils.

— *gigantea* Vent. Some material in the Botanical Museum of Copenhagen, determined by W. Trelease, shows terete, bulb-like bulbils.

— *macrophylla* Hook. Trelease 1910 Taf. 37. The bulbils terete, bulb-like.

— *Selloa* K. Koch. Bot. Mag. tab. 6148 distinct terete bulbils.

— *tuberosa* Ait. Some material in the Botanical Museum of Copenhagen (det. W. Trelease) shows terete, bulb-like bulbils. Concerning *F. lipsiensis* (fide Drummond = *F. tuberosa* Ait.) Jacobi 1869 p. 169 says, that the bulbils resembles "Gartenzwiebeln".

— *undulata* Jacobi. To judge from Bot. Mag. 6160 and 7250, these both represent the same species (fide Drummond), the bulbils are terete also in this species.

Only in *F. stricta* Jacobi 1869 p. 171—74 the bulbils are mentioned in the following words: . . . “sehr zahlreiche ogivale, theils seitlich etwas plattgedrückte, theils unscheinbar stumpflich dreikantige Bulben”.

I think it probable that the bulbils of all species of *Furcraea* hitherto known, *F. stricta* only excepted, are terete, bulb-like, as possible deviations from that shape would certainly have been noticed by the authors.

F. stricta resembles in many points *F. stratiotes*, though distinct differences are present. *F. stricta* is mentioned by Drummond (1907 p. 57) as being closely related to or even identical with *F. elegans* Todaro or *F. macrophylla* Hook. I am of opinion that Drummond is wrong here. I contend that *F. stricta* ought doubtlessly to be referred to Drummond’s group A. Minores together with *F. undulata*. Unfortunately it will certainly be impossible ever completely to elucidate *F. stricta* (cfr. Drummond 1907 p. 57).

I think that the species allied to *F. stratiotes* may be grouped thus when employing Drummond’s system as shown in the following key: Sect. II. Spinosae.

A. Minores.
- a. Bulbils terete, 15—30 leaves in the rosette
  F. undulata Jacobi
  (*F. albispina* Baker?)
- b. Bulbils more or less compressed, 30—50 leaves in the rosette.
  1. Bulbils slightly compressed, leaves rough below. Flowers large, about 30 leaves in the rosette (fide Baker 1888 p. 201) .... *F. stricta* Jacobi
  2. Bulbils very compressed, leaves smooth on both surfaces, flowers minute, about 50 leaves in the rosette .... *F. stratiotes* n. sp.

The terete, bulb-like bulbils is certainly a characteristic common to all the species of the group B. Giganteae. Of the species of this group *F. cubensis* probably approaches nearest to *F. stratiotes*. *F. cubensis* however distinctly differs mainly by 1) the terete, bulb-like bulbils, 2) the flowers being twice as large, 3) the broader leaves and 4) the simple spines in the margin of the leaves.

The Botanical Museum of the University. Copenhagen. Febr. 1921.

Bibliography.

Baker, J. G., 1888. Handbook of the Amaryllideæ. London.

Drummond, J. R., 1907. The literature of Furcraea with a synopsis o the known species. Missouri Bot. Gard. Eighteenth Report. St. Louis.

v. Jacobi, 1869. Nachträge zu dem Versuch einer systematischen Ordnung der Agaveen. Abhandl. der Schles. Ges. f. vaterländ. Cultur. Abth. f. Naturwiss. u. Medicin.

Jacquin, N. J., 1763. Selectarum stirpium americanarum Historia. Vindobonæ.

Kunth, C. S., 1850. Enumeratio plantarum. Tomus 5. Stuttgart et Tübingen.

Todaro, A., 1876—78. Hortus botanicus Panormitanus. Tom. I.

Trelease, W., 1910. Observations on Furcraea. Ann. du Jard. bot. de Buitenzorg. 3. Suppl. 2e Partie.

Ventenat, C., 1796. Furcraea. Novum Plantæ Genus descriptum. Annalen der Botanik herausgegeben von Dr. Paulus Usteri. 19, p. 54.

Explanation of the plate IV.

Fig. 1. *Furcraea stratiotes* n. sp. showing the habit of the entire plant.

— 2. — — —, the rosette with double-spined leaves, and the base of the scape with the lowest denticulate bract.

— 3. — — —, the panicle with numerous compressed bulbils and some flowers.

En ny Art af Furcraea fra Nicaragua.

Af

Johs. Boye Petersen.

I Aaret 1848 rejste daværende Mag. A. S. Ørsted i Mellemamerika for at gøre botaniske Indsamlinger. Han hjemsendte store Mængder af tørrede Planter, der nu er noget af det værdifuldeste, vort botaniske Museum rummer. Tillige samlede han Frø og levende Planter til den botaniske Have, der den Gang laa ved Charlottenborg. De fleste af disse Planter er selvfølgelig forlængst forsvundne igen; men enkelte af dem er bevaret op til Nutiden og flyttedes til den nuværende botaniske Have i 1874. For nogle Aar siden blomstrede her for første Gang *Agave guatemalensis*, og i Slutningen af 1921 kom endnu en Plante i Blomst, som stod under Navnet *Agave* sp. og stammede fra Nicaragua. Det viste sig, at denne snart 71 Aar gamle Plante i Virkeligheden ikke hørte til Slægten Agave, men til

Naboslægten Furcraea; men den kunde ikke henføres til nogen af de kendte Arter af denne Slægt og beskrives derfor som en ny Art under Navnet *Furcraea stratiotes* n. sp. Den har en Roset af stive Blade, der paa Randen, er besatte med ejendommelige dobbelte Torne, en 2 m høj Blomsterstængel der bærer en stærkt grenet Blomsterstand. Blomsterne, der er duftende og med nærmest flødefarvet Bloster, visnede alle, saa at den ikke satte Frugt; men i Blomsterstanden og langt ned ad Stængelen fremkom i Bladhjørnerne en Mængde stærkt sammentrykte Yngleknopper. Disse minder noget om Blomsterknoppen hos Krebseklo (*Stratiotes aloides*), og herfra stammer Plantens Navn. Ved Hjælp af disse Yngleknopper kan det nu lykkes at bevare Arten og faa den udbredt i de botaniske Haver. Selve den gamle Plante derimod gaar ud efter Blomstringen. Nær beslægtet med *F. stratiotes* er *F. cubensis* (Jacq.), der hører hjemme paa Cuba, men dyrkes flere Steder i Vestindien, idet man bruger dens sejge Bladtaver som Tekstilmateriale.

Typ. Bianco Luno. Kbhvn



Fig. 1.



Fig. 2.



Fig. 3.

Særtryk af Botanisk Tidsskrift. 37. Binds 5. Hefte. 1922.

Studies on the Collective Species Viola tricolor L. II.

By

J. Clausen.

I. The varying Characters of *V. tricolor* and *V. arvensis.*

In the first paper I published on *Viola tricolor* (Clausen 1921), I mentioned 6 varying characters and the variations of those examined in nature. I stated that nearly all possible combinations of 4 characters were found realized among 1000 individuals. I will here give a brief account of the variations I hitherto have examined in *Viola arvensis-tricolor*. As in the first paper, the abbreviations employed for the characters are shown in brackets.

1. The size of the petals:
   Small petals (*parv*) = *arvensis.*
   Large petals (*grand*) = *tricolor.*
   Should one refer any individual belonging to the collective species *V. tricolor*, either to *arvensis* or *tricolor* (in a more restricted sense) only this character ought to be applied to the distinction.
2. The stigma:
   Without labellum (*n.lab*): typical *arvensis.*
   With labellum (*lab*): typical *tricolor.*
3. A dark spot in front of the style:
   Without spot (*n.mac*): typical *arvensis.*
   With spot (*mac*): typical *tricolor.*
4. The pollen-magazine:
   Open (*ap*): typical *arvensis.*
   Closed (*cl*): typical *tricolor.*
   Half-closed (*sem.cl*): hybrids?

5. The honey-streak:
   Without streak (*erad* = eradiata): occasionally in plants of hybridal origin.
   With non furcate streak (*n.furc*).
   With furcate streak (*furc*).
6. The colours of the petals:
   Yellowish white (*albid*): typical *arvensis*.
   And the colour-variations of *tricolor:* Blue (*viol*), Bright yellow (*lut*), Rose-red (or red-lilac) (*rosea*), a Pale blue (*pall* = pallida), Pure white (*alba*).
   The colours must be determined upon elder flowers.

Most of these variations were mentioned in the paper from 1921.

7. The length of the spur:
   It is not expedient to state the length of the spur in absolute measures, because it is dependent on external conditions. In determining the length of the spur I have applied the ratio between the length of the appendices of the sepals and the length of the spur, because this ratio is very easy to determine. Both the size of the appendices and the length of the spur are varying dimensions, and they are in some way independent of each other, so that the ratio to some extent is the result of two varying characters.
   V. arvensis has a spur as long as the appendices or a little shorter. *V. tricolor*'s spur is a little longer. But in the dunes of West-Jutland and Læso, types of *tricolor* are found, whose spur is more than twice as long as the appendices (fig. 1 *c*). This ratio is due to both the long spur and the short appendices. As I have used this character to determine the variation of plants from dune populations, I have only distinguished the following two types:
   Short spur (*brev.calc* = brevicalcarata): the length of the spur twice the length of the appendices or less.
   Long spur (*long.calc* = longicalcarata): the length of the spur more than twice the length of the appendices (fig. 1 *c*).
8. The form of the spur:
   Spur straight (*rect.calc* = calcar rectum): the most common type.
   Spur bent upwards (*incurv.calc* = calcar incurvatum): most commonly found among the *tricolor*-types with long spur from the dunes.



Fig. 1. Leaves and flowers from different types. ($^5/_6$).

a: *V. arvensis typica* from moor near Hillerod, Sealand: petals *parv*, leaf *ovat-cren*, stipules *pinn.*
b: *V. tricolor typica* from grass-field at Emmerlev, Southwest-Jutland: petals *grand*, leaf *lanc-serr*, stipules *palm.*
c: *V. tricolor maritima* from Læso: petals *grand*, spur *long.calc*, *parvifoliata.*
d: Leaf and stipules of *V. arvensis* from Tysinge Moor near Tollose, Sealand: leaf *ovat-cren*, stipules *pinn*, *foliac.*
e: *V. arvensis* from Tunø, population T, table I. Leaf and stipules very large, nearly as long as the peduncle; stipules *pinn*, *foliac.*

9. The form of the spur-bearing petal:
   Commonly the spur-bearing petal both in *arvensis* and *tricolor* is truncate or faintly emarginate; but in the dunes of the northern part of West-Jutland and upon Læsø types of *tricolor* are found, where this petal is pointed (CLAUSEN 1921, p. 209, fig. 1). I therefore distinguish the following two types:
   Pointed (*acum* = acuminata): fig. 2.
   Not pointed (*n.acum* = non acuminata).



Fig. 2 ($^1/_1$). *V. tricolor maritima* from Læsø: lateral petals *emarg*, spur-bearing petal *acum*.

10. The lateral sepals:
   I have found a special character of these in some *tricolors* from dunes upon Læsø. The lateral sepals are somewhat incised at the tips: (fig. 2). This character was not previously known, and perhaps Læso is the only place in the world, where it can be found; and probably it came into existence there endemically, by a mutation:
   Lateral sepals entire (*integ* = integerrima).
   Lateral sepals emarginate (*emarg* = emarginata).
11. The epidermis-cells of the petals:
   The surface of the petals of the majority of pansies from the gardens is velvet-like. This character is due to the epidermis-cells, which are extended to many densely placed small microscopic papils (fig. 3 *a*). The common wild types have not so large and so densely placed epidermis-papils, that the surface becomes velvet-like; but at Hadsund (Jutland) I have found a type of *tricolor* growing wild with velvet-like petals. This character I call velutina (*velut*).
   Common, not velvet-like petals: non-velutina (*n.velut*).
12. The pollen-grains:
   In a dry state the pollen-grains are shrunken, but they are able to absorb water very quickly. Then they swell and assume a characteristic form: seen from the edge they are ellipsoidal with a protuberant equatorial-belt (fig. 3 *b*), but seen from above they appear either 4- or 5-edged (fig. 3 *d*, *e*), less frequently 3- or 6-edged (fig. 3 *c*, *f*). It is the protuberant equatorial-belt giving them this edged appearance.

The pollen-grains of *V. tricolor* are 4-edged, but furthermore the same plant can have a few 3- and 5-edged. The grains of *V. arvensis* are 5-edged, but the same plant can besides have some 4- or 6-edged or both. Finally, types are found that have just as many 4-edged as 5-edged pollen-grains. I suppose these to be of hybrid origin.

13. The leaf-size:

This character varies in a high degree, but as it is highly dependent on external conditions, the variations are not

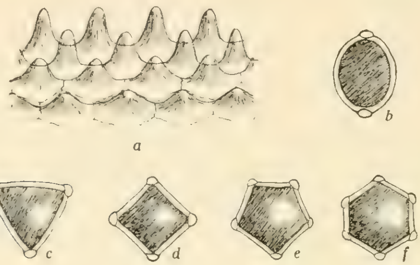


Fig. 3.
a: Epidermis-cells from petals ($^{150}/_{1}$).
b: Pollen-grain seen from the edge.
c, d, e, f: Pollen-grains seen from above.
a-f: $^{125}/_{1}$.

easy to determine. The sizes must at least be stated in proportion to some other organ on the plant, for instance the length of the leaves in proportion to the length of the peduncles. Commonly the length of the full grown peduncles is about twice that of the leaves.

However I have found another type of leaves in the dune populations. They are very short and narrow (fig. 1 *c*). These leaves have always been somewhat fleshy, too. The surface of a leaf of this type is only about $^{1}/_{3}$—$^{1}/_{4}$ of that of a corresponding leaf of a common type. Fig. 4 *b* and *c* are leaves of parvifoliate resp. grandifoliate types at the same stage and grown under the same conditions.

I found leaves of an extremely large size in an *arvensis*-population upon Tuno (an island in Kattegat) fig. 1 *e*. The leaves were just as long as the peduncles. Hybrids often have very large leaves.

The leaf with the largest surface is most favourable to assimilation, but it gives (all other conditions alike) the largest transpiration too. I have compared the epidermis of the leaves of the parvifoliate types from the dunes with



Fig. 4 $(^1/_1)$.

a: *V. arvensis* from Koldby Kaas, Samsø (population U, table I): petals *parv*, leaf *lanc-serr*, stipules *palm.*

b: Leaf of *V. tricolor maritima* from Læsø: *parvifoliata.*

c: Leaf of *V. tricolor* from fields: *grandifoliata.*

The leaves *b* and *c* were both from the rosette at the basis of the plant.

those of the common types and have not been able to detect any difference between them in the number of stomata per unity of area. Therefore, the small leaves on the plants from the dunes must undoubtedly be favourable in reducing the strong transpiration in these places. Just in the dunes we find almost exclusively parvifoliate types.

14. The form of the leaves:

Two extreme types can be distinguished:

Ovate, crenate leaves (*ovat-cren*): fig. 1 *a*, common in *V. arvensis.*

Lanceolate, serrate leaves (*lanc-serr*): fig. 1 *b*, common in *V. tricolor.*

But as these two characters are transgrediating, and the rosulate leaves are quite different from the upper ones, they are difficult to distinguish in practice. Sometimes plants can be found that have ovate, crenate leaves but in all other characters are typical *tricolor*, and on the contrary plants that have lanceolate, serrate leaves can in all other characters be *arvensis*-like.

15. The stipules:

The most typical *V. tricolors* have palmate stipules (fig. 1 *b*), but *V. arvensis* has pinnate stipules (fig. 1 *a*). As these two characters are transgrediating, I have provisionally distinguished the two types in the following way:

Pinnate stipules (*pinn*): at least one stipule pinnate.

Palmate stipules (*palm*): all the stipules palmate.

Fig. 4 *a* shows an *arvensis* with palmate stipules.

16. The end-lobe of the stipules:

In some types the end-lobe of the stipules is foliaceous and petiolate (fig. 1 *d*; the end-lobe in fig. 1 *e* is foliaceous but not petiolate). When the end-lobe is crenate, it has the character of a leaf.

Foliaceous end-lobe of the stipules: (*foliac*). The end-lobe not foliaceous (not crenate): (*n.foliac*).

In such stipules as those in fig. 1 *d* and 1 *c* the assimilating area is highly increased. The character *foliacea* can be found combined with either pinnate or palmate stipules.

17. The growth-form:

Most pansies have ascending stems, they are negative geotropic. But many of the types from the dunes of West Jutland have transversely geotropic stems. Already when the young plants leave the rosulate stage, the stems press themselves against the surface of the earth. Sometimes the pressure can be so strong that, when the plants are drawn up, the turgor bends the stems downwards with vigour (see fig. 5 *b*. In fig. 5 *c* a branch of the same plant is shown. On



Fig. 5 (2/3).

a: *V. tricolor* from field, S. Lyngvig, Holmsland Klit: *erecta, n.atropurp, grandifol.* (Population Y, table I).

b: *V. tricolor maritima* from dune, S. Lyngvig, Holmsland Klit: *prostrata, atropurp, parvifol, caespitosa.* The light parts were covered with sand. The turgor has bent the stems downwards with vigour.

c: A branch of *b* with flower. The light parts of it was covered with sand. The subterraneous parts are negative geotropic, the supraterraneous are transversely geotropic.

the surface of the earth the stem is bent horizontally at right angles). The subterraneous parts of stems of these plants are negative geotropic as fig. 5 *b* and *c* show. I distinguish two types of growth-form:

Erect stems (negative geotropic): (*erect*).

Prostrate stems (transversely geotropic): (*prostr*).

At the beginning of autumn some of the most erect types bend their stems downwards horizontally, but the apices of the stems are always erect, and thus these phenotypically prostrate plants are easy to distinguish from the other genotypically prostrate.

18. The colour of the stem:

I distinguish 2 types:

Plants containing a large quantity of anthocyanin (*atrop* = atropurpurea): dark violet stems.

Plants with fresh green stems (*n.atrop* = non atropurpurea).

In the dunes of West-Jutland and Læsø nearly all the pansies are *atropurpurea*. The plants from the fields are usually *non atropurpurea*. The plants with albinotic flowers have pale green leaves and stems (*chlorina*), but as this character is coupled with *alba*, I have not taken it into consideration here.

19. Duration of Life:

Viola tricolor and *arvensis* are as a rule annual. They are Therophytes which regard the dry summer-time as the most unfavourable season. In many fields *arvensis* only lives from autumn to early summer (is winter-annual). *V. tricolor* can better survive the dry season. On the other hand, in dunes and in pine forests most individuals of *Viola tricolor* are perennial. An essential condition for perennity in our latitudes is that the plants either are able to produce subterraneous side-branches or are able to ramify strongly in the surface of the earth. Commonly *Viola tricolor* and *arvensis* lack this capacity in contradistinction to *V. cornuta-calcarata*. In dunes the sand-heaping and in pine woods the falling of acicular leaves replace this capacity of the plant, as the lower parts of the stems with their buds are covered by these agencies. From the covered parts the plants shoot adventitious roots and subterraneous branches

(fig. 5 *b*, *c*). The subterraneous leaves are white and scale-like, without any resemblance to the supraterraneous. Consequently many of the perennial pansies from the dunes and pine forests are merely phenotypically perennial. But the perennial types from the dunes of West-Jutland and upon Læso possess some characters which better enables them to survive the unfavourable seasons and conditions, and therefore these types are genotypically perennial. These characters are:

a. A very high degree of ramification (the character *caespitosa*) in the earth-crust, exceeding many times that of the common *Viola tricolor* and sometimes that of *calcarata-cornuta* too. Fig. 5 *b* is a very moderately ramified individual. It is not uncommon to find individuals with more than 20 and even up to 50 side-branches.
b. Transversal geotropism (*prostrata*), common among the individuals in these dunes, is a character that facilitates the covering with sand.
c. Transpiration is reduced, partly by the character *parvifolia* and partly by *prostrata*. This reduction is of great importance for the survival during the unfavourable season.
d. The plentiful Anthocyanin in the leaves and stems of these types (the character *atropurpurea*) is supposed to be a protection against too much light.

Therefore the perennity is most frequently the result of a co-operation of the named genotypically conditioned characters, but as the first one is the most essential, and besides the only one not mentioned before I here distinguish only two types and determine them according to the ramification:

Perennial (*caesp* = caespitosa): high degree of ramification in the earth's crust (more than 6 side-branches).

Annual (*n.caesp*): When not covered, only side-branches above the surface of earth, the side-branches not rosulate and sparse.

The two types are transgrediating.

As will be seen from the foregoing, the characters in several cases are rather difficult to distinguish from each other, and the list here given is not exhaustive. As for stipules for instance there are more types than the four mentioned, but on the other hand each *V. tricolor* or *arvensis* can as regards stipules be placed under one of the 4 types. The limitation of all the quantative, transgrediating characters against each other is also difficult, but I suppose that a limit, even an arbitrary one, is always to prefer to a description, in common terms, of the habitual appearance, that never can be so concise and so easy to compare as the statement of a numeric relation.

II. Are the Variations induced by Genotypical Differences?

This problem I have tried to solve in different ways.

1. By observation in nature. In many habitats I found the different characters realized in plants growing together under the same conditions. Plants with violet petals and yellow petals, with long spur and short spur, with straight spur and incurved spur, with erect stems and prostrate stems grow intermixed in the same habitat, and when they are different, it must be due to the genotypical differences. The tables I and II (p. 378 and 381) state the extent in which the different characters found are realized in the same habitat.
2. By cultivation of the types under the same conditions. In several cases I found marked differences between the composition of the populations from habitats the conditions of which differed considerably. On the narrow isthmus Holmsland Klit between Ringkobing Fjord and the North Sea I found two such populations. A road runs lengthways through the isthmus and separates the dunes on the western seaside from the clayey and more fertile fields on the eastern fjord-side. There is but a few steps between these two localities. Both in the dunes and in the fields there were populations of *Viola tricolor* but of two very different types what can be seen in fig. 5. In the dunes all the plants were *parvifoliata* (leaves of the thick, somewhat fleshy type common in the dunes of West-Jutland), the stems and the leaves were *atropurpurea*, most of them were *prostrate* and *caespitose* perennials (fig. 5 *b*, *c*). Otherwise in the fields

on the other side of the road: all the plants were as fig. 5 *a*: *grandifoliata*, *non atropurpurea*, *erecta* and *non caespitosa* (Table I, population Y, page 379). Apparently the characters of the type from the dunes were favourable to the plants under the conditions of life there. One might presume that the diverging appearance of this afore-mentioned type was a modification induced by the external conditions. The most exact method to prove whether the extreme characters were phenotypically or genotypically induced would have been to take the plants from these populations and propagate them in clons under identical conditions in order to see if they became identical. I did not do so, but instead of that I collected seeds from the two types and these were sown under identical conditions in the Botanical Garden, Copenhagen. They bred true to type: all plants of seeds from the dune became *parvifoliata*, *atropurpurea* and all plants of seeds from the field became *grandifoliata*, *non atropurpurea*, the offspring being just as different as the mothertypes in fig. 5 *a* and *b*. By this it was proved that the extreme characters were hereditary and not induced by the conditions.

All the above mentioned characters I have tried under cultivation, and they proved to be genotypically conditioned. Sometimes a segregation was noticed: some of the *prostrata* plants taken in nature are homozygotic and some are heterozygotic, and therefore seeds of them show segregation in *erecta* and *prostrata*. — Seeds of an albinotic *tricolor* gave many albinotic and a few violet plants; (*alba* is recessive, and the violet plants were from seeds pollinated with pollen from violet flowering plants). — The first plant cultivated with the character *emarginata* (lateral sepals) was homozygotic and gave by self-fertilization only *emarginata* individuals.

On the whole, most of the types collected in nature show no segregation except in such characters as the flower-colours *lutea* and *violacea* (*tricolor*) and in the characters *maculata* and *non maculata* (the style); likely they are homozygous in most characters. The probable cause to this phenomenon will be discussed later.

3. By researches in Genetics. The different characters have been crossed in order to determine the factors and the limit of the characters against each other. It will still take

some time to complete these investigations, but they show interesting facts. They confirm the results attained by the two other methods, that the variations of the characters are induced by genotypical differences.

III. Are all Combinations of the Characters possible?

In the paper from 1921 I reported about the combinations of the 6 first mentioned characters. In the meantime, I have examined a great number of individuals from different habitats in order to decide if all combinations of the remaining characters are likely to occur, and to get information as to which combinations are the most frequent. The characters were examined in sets of 4, 5 or 6 at a time. Within the sets practically all combinations can be found. Characters from different sets have been examined together too and, as they also combine in different ways, I suppose it justifiable to infer that, on the whole, all combinations can be realized. Of course I have not seen all possible combinations of all these characters. It would take more than a lifetime to examine only one individual of each combination, and I do not believe that they are realized all simultaneously.

In table I next page a summary is given of the combinations of four characters that are easy to determine even on exsiccata. The results from 23 habitats are given in the table. In each place 50 or 100 individuals were taken and determined. The numbers in the table are egalized so, that they in all cases indicate the number of individuals of the combination (isoreagent) in question per 100 individuals from that habitat. The four characters are: size of petals, colour of petals, stipules and end-lobe of stipules. The order of the characters is not indifferent; they ought to be taken in the afore-mentioned order, as the bulk of the individuals by this method is placed in two groups, one at the top and one at the bottom, corresponding to the two species in question: *V. tricolor* (at the bottom) and *V. arvensis* (at the top). In the middle the fairly rare irrelevant types are to be found. As to the flower-colours I have only taken two alternatives here, as there is a great difference between the *arvensis*-colour *albida* on the one hand, and all the *tricolor*-colours *violacea*, *lutea*, *rosea* and *alba* on the other.

Each of the 23 habitats has its column in the table indicated

Table

Size of petals	Colour of petals	Stipules	End-lobe of stipules	A	B	C	D	E	F	G	H	I	J	K	L
Reaction of soil				basic						neutral					
parv	*albid*	*pinn*	*foliac*	»	66	»	8	56	»	85	»	»	2	»	»
			n.foliac	×	34	92	76	36	»	15	×	8	14	34	»
		palm	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	8	16	8	»	»	×	8	2	»	»
	viol, lut	*pinn*	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	»	»	»	»	»	×	4	4	3	»
		palm	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	»	»	»	»	»	×	6	»	3	»
grand	*albid*	*pinn*	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	»	»	»	»	»	»	»	»	»	»
		palm	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	»	»	»	»	»	»	»	»	»	»
	viol, lut	*pinn*	*foliac*	»	»	»	»	»	»	»	»	»	6	»	»
			n.foliac	»	»	»	»	»	×	»	×	26	44	9	56
		palm	*foliac*	»	»	»	»	»	»	»	»	»	»	»	»
			n.foliac	»	»	»	»	»	×	»	»	48	28	51	44
				×	100	100	100	100	×	100	×	100	100	100	100

Populations:

A: Grass field at Onsild, Mid-Jutland, basic, marle strate. 28th May 1921.

B: Grass field at Andrup, Mols, East-Jutland, basic. 2nd June 1921.

C: Grass field near Skorping, East-Himmerland, basic, marle strates 28th May 1921.

D: Grass field at Bælum, East-Himmerland, lime countries, basic. 31st May 1921.

E: Rye field on lime-hill south of Smidie, East-Himmerland, basic. 31st May 1921.

F: Grass field on Holmsland, West-Jutland (marle), basic. 25th May 1921.

G: Grass field between Grønfeld and Egens, Mols, East-Jutland, neutral. 2nd June 1921.

H: Sandy grass field near Vorgaard, East-Himmerland, neutral. 31st May 1921.

I: Sandy grass field at Vejrumhede, Mid-Jutland, neutral. 18th May 1921.

J: Sandy grass field near Terndrup, East-Himmerland, neutral. 31st May 1921.

K: Grass field south of Hadsund, East-Jutland, neutral. 1st June 1921.

I.

faintly acid			acid					not known			Summa		
M	N	O	P	R	S	T	U	V	X	Y			
»	»	»	»	»	»	64	»	»	»	»	281	652	712
8	12	2	»	»	»	30	× (1)	8	2	»	371		
»	»	»	»	»	»	»	»	»	»	»	»	60	
»	6	»	»	»	»	6	×(13)	6	»	»	60		
»	»	»	»	»	»	»	»	»	»	»	»	25	46
»	12	»	»	»	»	»	»	»	2	»	25		
»	»	»	»	»	»	»	»	»	»	»	»	21	
2	10	»	»	»	»	»	»	»	»	»	21		
»	»	»	»	»	»	»	»	»	»	»	»	6	12
»	»	6	»	»	»	»	»	»	»	»	6		
»	»	2	»	»	»	»	»	»	»	»	2	6	
2	2	»	»	»	»	»	»	»	»	»	4		
»	»	»	»	»	»	»	»	»	»	»	6	449	1130
32	8	40	34	30	22	»	»	16	84	42	443		
»	2	»	»	»	»	»	»	»	»	»	2	681	
56	48	50	66	70	78	»	»	70	12	58	679		
100	100	100	100	100	100	100	×	100	100	100	1900	1900	1900

L: Grass field at Assentoft, east of Randers, East-Jutland, neutral. 1st June 1921.

M: Grass field east of Viborg, Mid-Jutland, faintly acid. 28th May 1921.

N: Grass field east of Vejrumhede, Mid-Jutland, faintly acid. 28th May 1921.

O: Sandy cleared space in plantation of spruce fir, north of Hadsund, East-Jutland, acid. 31st May 1921.

P: Sandy grass field at Oxbøl, west of Varde, West-Jutland, acid. 24th May 1921.

R: Uncultivated sandy *Anthoxanthum-Scleranthus* formation in Mols Hills, East-Jutland, strongly acid. 2nd June 1921.

S: Sandy grass field near Isseboved, Samsø, strongly acid. 3rd June 1921.

T: Stony rye field at Tunø harbour, strongly acid. 3rd June 1921.

U: Sandy grass field at Koldby Kaas, Samsø, strongly acid. 4th June 1921.

V: Sandy grass field near Røde-Kro, South-Jutland. 21st May 1921.

X: Dune field at Selvig, Samsø. 3rd June 1921.

Y: Grass field between N. and S. Lyngvig, Holmsland Klit, West-Jutland. 25th May 1921.

Characters:

Size of petals:
parv = petals $\leq$ the sepals.
grand = petals $>$ the sepals.

Colour of petals:
albid = yellowish white.
viol, (*lut*) = blue or one of the other *tricolor*-colours.

Stipules:
pinn = pinnate.
palm = palmate.

End-lobe of stipules:
foliac = foliaceous.
n.foliac = not foliaceous.

by capital letters, which refer to the explanation below. Each of the 16 combinations or isoreagents has a rubric in the table, and the number per cent is stated off each habitat. In some cases the number of individuals from a special habitat has been too inconsiderable to be stated per cent, and sometimes no statistics have been made. In these cases the Isoreagents noticed in the habitat are indicated by a cross.

In some of the habitats only *arvensis*-like combinations are found, in others only *tricolor*-like combinations, in others again nearly all combinations are represented. *Parv*, *albid* and *grand*, *viol* are the two most common combinations, respectively 712 and 1130 individuals from 1900. The combinations *parv*, *viol* and *grand*, *albid* are rare (only 46 and 12 out of 1900).

Table II next page shows the combinations of some of the characters marking the *tricolors* from the dunes of Læso and West-Jutland. Mr. C. A. Jørgensen has been so kind to make up the lists Z, Æ, Ø from Læso in 1921, as it was of interest for me to know in which combinations the character *emarginata* was able to occur. (I observed this character in summer 1921 in plants from seeds I had collected on Læso 1919). For the populations A A and B B only form of stipules, length of calcar and colour of stems are indicated.

All the *Viola* in the dunes are *grand*, *lab*, *non albida* (*viol*) and certainly *parvifoliata*. The last mentioned character is difficult to compare from different localities, except by cultivation under the same conditions. Most of them are *atropurpurea* too. But in other characters all combinations are realized.

All combinations of characters, I have tried, have proved the same, and there is a multiplicity of possibilities for variations within the collective species.

Table II.

Petals	Stipules	Calcar		Lateral Petals	Z	Æ	Ø	Summa	Stems	AA	BB
grand, viol (lut)	*pinn*	*brev. calc*	*rect*	*integ*	2	»	8	10	*n. atrop*	4	»
				emarg	2	8	»	10			
			incurv	*integ*	»	»	4	4	*atrop*	30	36
				emarg	2	4	»	6			
		long. calc	*rect*	*integ*	2	»	»	2	*n. atrop*	2	»
				emarg	»	»	»	»			
			incurv	*integ*	»	8	20	28	*atrop*	34	24
				emarg	2	12	»	14			
	palm	*brev. calc*	*rect*	*integ*	18	16	12	46	*n. atrop*	4	»
				emarg	16	16	»	32			
			incurv	*integ*	16	»	16	32	*atrop*	14	40
				emarg	10	12	»	22			
		long. calc	*rect*	*integ*	16	»	»	16	*n. atrop*	2	»
				emarg	8	4	»	12			
			incurv	*integ*	2	»	36	38	*atrop*	10	»
				emarg	4	20	4	28			
					100	100	100	300		100	100
				°/o *acum*...	74	84	100				

Populations:

Z, Æ, Ø: Dunes on Læsø, 12th July 1921 (C. A. Jørgensen), Z nearest to Højsandene and Ø nearest to Vesterøhavn.
AA....: White dune at Nymindegab, 24th May 1921, many *rosea*.
BB....: Grey dunes from Ringkøbing Fjord to Nissum Fjord. 26th May 1921.

Characters:

Stipules:
pinn = pinnate.
palm = palmate.

Calcar:
brev.calc: calcar twice as long as the appendices or less.
long.calc: calcar more than twice as long as the appendices.
rect = calcar straight.
incurv = calcar bent upwards.

Lateral petals:
integ = entire.
emarg = emarginate.

Stems:
atrop = atropurpurea.
n.atrop = not atropurpurea.

Spur-bearing petal:
acum = pointed, (the remaining were not pointed.)

IV. The cause of the variation.

The multitudinous different isoreagents (genotypically conditioned variations, microspecies) within the collective species *Viola tricolor L.* have arisen from crosses between *V. tricolor* and *V. arvensis* and between the segregation products from these crosses.

In the paper from 1921 I proposed this theory, and I am now able to confirm it. The evidences are threefold:

1. Analytical evidence.

Seeds of plants from populations with both *arvensis*, *tricolor* and the *intermediate* types give by sowing not only the mother-type but also the other combinations. This is characteristic for hybrids. An instance will show this clearly:

In 1921 I collected seeds from the population F mentioned in the paper from 1921 (p. 210—211, table I and II), a stone-

Table III.

				F	V. 246	V. 247	
parv	*n. lab*	*albid*	*n.mac*	21	»	»	*arvensis*
			mac	21	4	4	
		viol	*n.mac*	9	2	»	
			mac	8	14	10	the mother type
		lut	*n.mac*	›	2	»	
			mac	»	»	»	
	lab, viol, mac			2	»	»	
grand	*n. lab*	*albid*	*n.mac*	1	1	»	
			mac	2	1	1	
		viol	*n.mac*	2	1	»	
			mac	8	1	»	
		lut	*n.mac*	»	»	»	
			mac	1	»	»	
	lab	*albid, mac*		6	»	»	
		viol	*n.mac*	1	1	1	
			mac	18	»	1	*tricolor*
				100	27	17	

quarry at Frederikshavn (see table III F in this paper). The seeds were derived from uncontrolled fertilization in nature. Seeds of two of these plants, both *parv*, *n.lab*, *viol*, *mac* (the size of flower was that of *arvensis*, the colour was *tricolor*'s) were sown as V. 246 and V. 247. The result can be seen from table III.

When these four characters are taken into consideration, the two plants have given, besides the mother type, 9 different combinations and among these one that I did not find in the original population (*parv*, *lut*). Some of these must be due to segregation and some of them to cross-fertilization, but in both cases it supports my theory. Moreover, from populations with *arvensis* or *tricolor* alone I have not obtained such segregations.

Some of the segregated types were selfed in 1921 and they gave in 1922 the following results:

V. 414: Mother plant: *grand*, *lab*, *lilacina*, *eradiata*, *n.mac. petalis latis* (in all a very peculiar type, that I have not seen in nature) gave only 9 plants, but they were all just as the mother plant.

V. 415: Mother plant: *parv*, *n.lab*, *lut*, *n.mac*, *petalis angustis* gave 8 plants all of the same type as the mother plant, but the size of the petals varied somewhat, as some of the plants had petals of the size of the sepals; other plants had smaller petals.

V. 416: Mother plant: *parv*, *n.lab*, *albida* (*with a hue of violacea*), *mac* segregated the following types (table IV):

Table IV.

parv	*n.lab*	*albid*	24
		lilac	2
		lut	1
	lab, albid		2
grand	*n.lab*	*albid*	1
		lilac	3
	lab	*albid*	»
		lilac	3

All 36 individuals were *mac*. Some of the plants had broad petals and some of them narrow.

lilac = *lilacina* (a hue of *violacea*).

V. 417: Mother plant: *grand*, *lab*, *viol*, *mac*, *petalis latis* gave 11 plants all as the mother plant (*tricolor*-type).

V. 418: Mother plant: *parv*, *n.lab*, *albid*, *mac* segregated the following types (table V):

Table V.

parv, n.lab	*albid*	*n.mac*	7
		mac	13
	lilac	*n.mac*	0
		mac	4

24 individuals (7 *n.mac*: 17 *mac*).

Some of these individuals have apparently become rather constant already and others segregated further.

All this is an evidence of the hybrid origin of the two mother plants to sowings V. 246 and V. 247.

2. Synthetic evidence.

As mentioned in my first paper, I crossed different types of *V. tricolor* with different types of *arvensis*. F_1 was intermediate in its appearance (in some characters there was full dominance). F_2, obtained in 1922, presented just the same multitudinous types as the populations from nature which I had suspected to be segregations from crosses between *arvensis* and *tricolor*. Such a segregation-field resembles just one of the populations I, J, K, M, N or O in table I, page 378. (The detailed results from these experiments will be published later on, when the results of the inquiry into the behaviour of the chromosomes after the hybridization can be stated).

3. Cytological evidence.

In the preliminary note I stated that *tricolor* had 13 chromosomes. As for *arvensis*, 17 chromosomes were found in several cases, but also types with 15 chromosomes existed. The further investigations have revealed that, as a rule, all relevant and stabilized types of *tricolor* and *arvensis* have respectively 13 and 17 chromosomes.

Fig. 6 *a* shows the homotypic metaphasis of an *arvensis* (*parv, albid, n.mac, pinn, foliac*) from Tuno (population T, table I, pag. 379). The type of the plant was like fig. 1 *e*, pag. 365. The divisions here goes on very regularly. 17 chromosomes.

Fig. 6 *b* shows the diakinesis of a *tricolor* (*grand, pall, mac, pinn, caespitosa*) from Selvig, Samso (population X, table I). Also

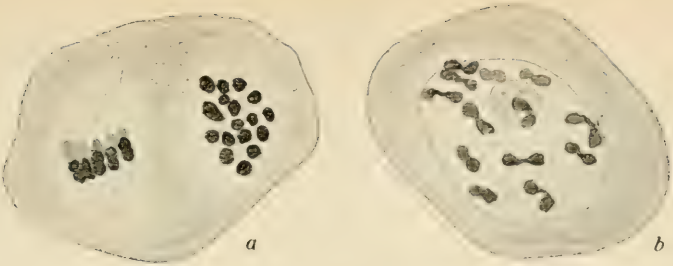


Fig. 6 ($^{2500}/_{1}$).

a: *V. arvensis* (population T, table I) from Tunø: homotypic metaphasis in a pollen-mother cell. 17 chromosomes.
b: *V. tricolor* (population X, table I) from Selvig, Samsø: diakinesis in a pollen-mother cell: 13 chromosomes.

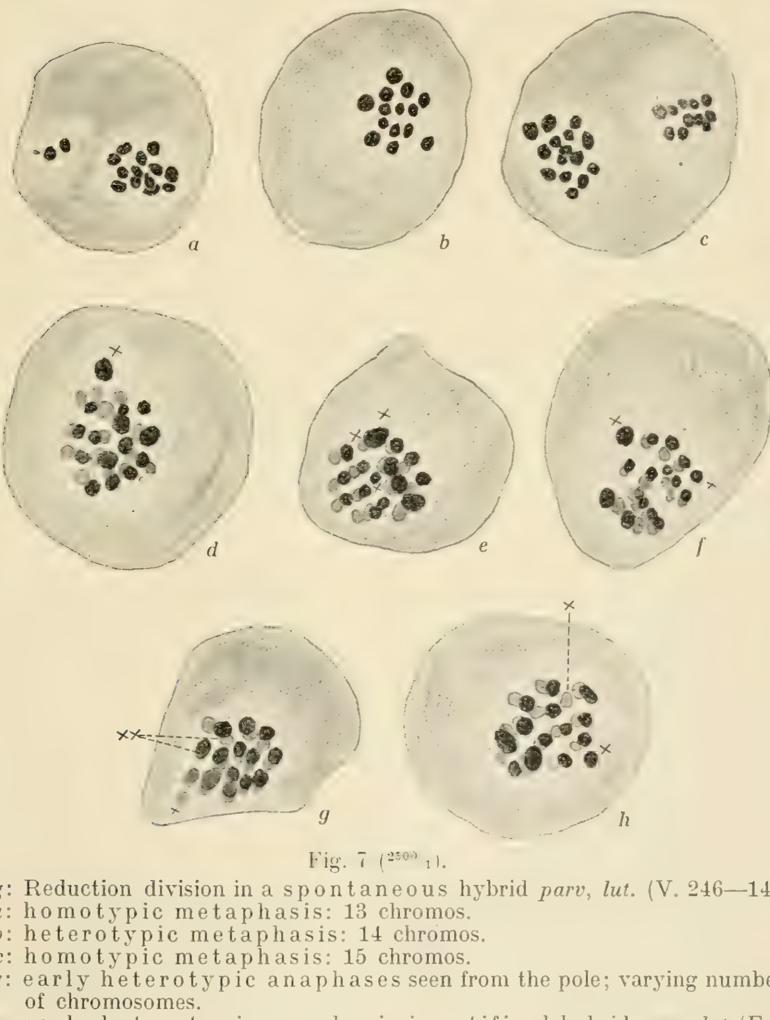


Fig. 7 ($^{2500}/_{1}$).

a-g: Reduction division in a spontaneous hybrid *parv, lut.* (V. 246—14).
a: homotypic metaphasis: 13 chromos.
b: heterotypic metaphasis: 14 chromos.
c: homotypic metaphasis: 15 chromos.
d-g: early heterotypic anaphases seen from the pole; varying number of chromosomes.
h: early heterotypic anaphasis in artifical hybrid *parv, lut* (F_1).

the division of this is very regular. The conjugation between the components is end to end and is complete. 13 gemini.

The intermediate types from the mixed populations are not so regular in their divisions, as shown in figs. 7 *a—g* and 8 *a—e*. It is the reduction of a plant from sowing V. 246, table III, p. 382 i. e.: a plant segregated from the very mixed population F in table III). Its formula was: *parv*, *n.lab*, *lut*, *n.mac*, *pinn*, *foliac* (*arvensis*' size of petals, but the colour of *tricolor*). It was the plant sown as V. 415 (p. 383). By its irregular divisions it discloses its hybrid origin.

In the early heterotypic anaphases seen from the pole most frequently 14 bivalent and 1 or 2 single chromosomes can be seen, as the following schedule over the pictured nuclei shows:

	bivalent	univalent (marked ×)	upper plate	lower plate	
Fig. 7. d	14	1 (large)	15 chromos.	14 chromos.	
— e	13	1 large 2 little	15 —	14 —	
— f	14	1 large 1 little	16 —	14 —	
— g	14 (the two marked × × only faintly joined)	1 (little)	14 —	15 —	
— h	13	2	14 —	14 —	Artificial hybrid

The chromosomes distribute irregularly to the poles, so that the anaphase-plates contain different numbers of chromosomes. One chromosome more or less seems not to afflict the viability of the plants. Just as irregular are the artificial hybrids. In the same anther nuclei with 13, 14, 15, 16, 17 and even with 11 and 12 chromosomes can be seen. Fig 7 *h* is of a beginning heterotypic anaphasis from F_1 of a cross *tricolor* × *arvensis* (13 chromos. × 17 chromos.). In the upper plate are 14 chromosomes and in the lower one are also 14, but one from each (marked ×) is single and not conjugated, just as in the spontaneous hybrid.

Fig. 8 shows the homotypic anaphases of the same spontaneous hybrid. The following schedule shows the irregularities in this division:

Fig. 8	Number of chromosomes	Chromosomes lost		
		in heterotyp. division	in homotyp. division	
Tetrad a	14 + 14	1	....	
— b	....	....	2	
— c	....	....	1	
— d	11 + 11	....	....	
— e	....	....	4 + 4	
— f	....	1	2 + 3	Artificial hybrid

There is a large accordance and similarity in the nuclear divisions between the artificial hybrids and the suspected, spontaneous hybrids.

When 13 *tricolor*-chromosomes and 17 *arvensis*-chromosomes are brought together, they behave in different ways in the heterotypic metaphasis. They can form either 15 bivalents, 14 bivalents and 2 univalents or 13 bivalents and 4 univalents. The most frequent is 14 bivalents. We must suppose that 13 *tricolor*-chromosomes join with 13 *arvensis*-chromosomes and, in addition, 2 *arvensis*-chromosomes join with each other forming the 14th pair. The univalent chromosomes in some cases go to different poles, in other cases to the same pole both, and in other cases again one or more of them are lost in the first or in the second division. Most frequently they are lost in the homotypic division. We must suppose that they can be lost during the vegetative mitoses too (Fig. 7 *d*, *g* and *h*). As I never yet have found *tricolors* with less than 13 chromosomes, I must suppose that pollen or eggs with less than this number, or the zygotes with less than 26 chromosomes degenerate.

This type of distribution of chromosomes after crosses was not previously known. The only one it resembles is the distribution in F_2 of a cross between *Solanum nigrum diploid* × *tetraploid* (72 chromosomes × 36 chromosomes) according to a discourse delivered by H. Winkler in the Deutsche Gesellschaft für Vererbungswissenschaft (H. Nachtsheim 1921). F_1 of this cross in its vegetative cells has 108 chromosomes, but in the reduction division it exhibits 54 bivalents, so that all the 36 chromosomes of the diploid parent must unite with 36 from the tetraploid and the remaining 36 from the tetraploid must unite mutually to form 18 pairs.

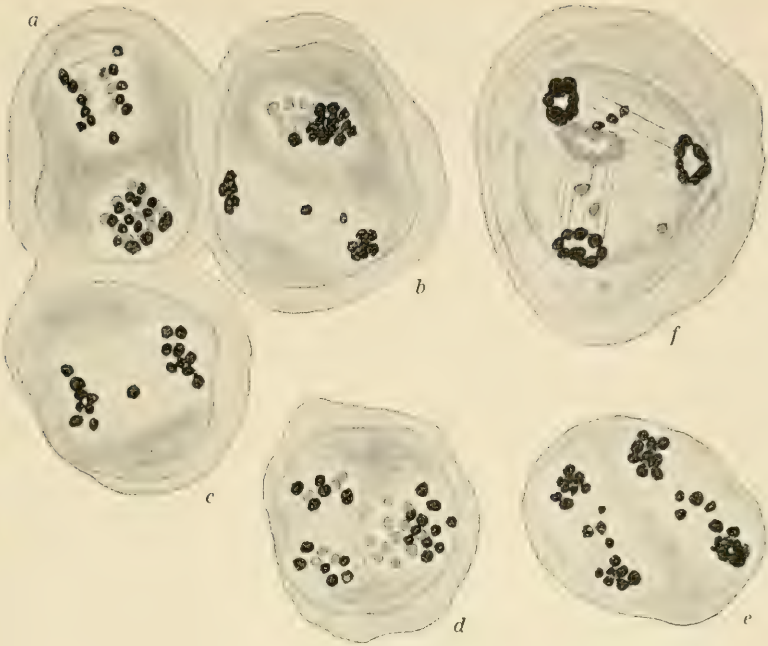


Fig. 8 ($^{2500}/_1$).

a-e: Homotypic ana-telophases in spontaneous hybrid *parv, lut.* (V. 246—14).

f: Homotypic telophasis in artificial hybrid *parv, pall* (F_1).

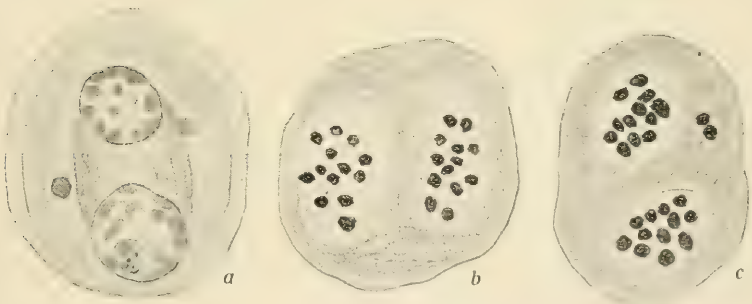


Fig. 9 ($^{2500}/_1$).

a-b: *V. tricolor nana.*

a: Interkinesis; 2 chromosomes are lost.

b: Homotypic metaphasis, regular. 13 + 13 chromosomes.

c: *V. tricolor lutea*; homotypic metaphasis. 12 + 12 chromosomes in the nuclear plates + 2 lost in heterotypic division.

F_2 of this cross agrees with F_1 of *tricolor* × *arvensis*, as the elimination of chromosomes in *Solanum* does not take place before in F_2. In one F_2-individual ROSE STOPPEL found 45, 41, 40, 38, 37, 36 and in another 54 and 55 chromosomes and so on. Both in *Viola* and *Solanum* some of the bivalents must be formed by chromosomes from the same parent. In *Solanum* F_1 is regular, but in *Viola* the irregularities begin already in F_1.

As usually only the two chromosome numbers 13 and 17 occur in nature, the chromosome-sets of the hybrids must for some reason or another be unstable, or the plants with these combinations of chromosomes can not be fit to the strong competition in nature. It is likely, that the offspring of a hybrid sooner or later ends in either a *tricolor* or an *arvensis*, i. e. in a 13- or in a 17-chromosome plant. But the chromosome-set of a *tricolor* that has come into existence in this way need not be identical with the parental *tricolor*. Likely a chromosome-exchange has taken place between the two chromosome-sets, so that the new *tricolor* has chromosomes both from the parental *tricolor* and the parental *arvensis* and in the same manner the new *arvensis* has chromosomes from the parental *tricolor* too. Consequently the factors carried by these chromosomes must be transferred together with these, so that we must expect to find *tricolors* that show some of the characters of *arvensis* and vice versa. In many places it is very difficult indeed to find a *Viola* typical in all its characters.

Even in the stabilized types, the reduction division can be irregular in some cases: In my cultures I have a curious little dwarftype. In 1919 I found in Sophienholm Hills, Sjælland, (CLAUSEN 1921, table I and II, population G, p. 220—221) a plant which I determined as *parv. pall.* It had very narrow petals and, according to its type, I expected it to approach *arvensis*. But, under cultivation, I observed that the petals or the sepals might vary slightly, so that the petals usually were a little longer than the sepals. It had a small labellum. I expected a segregation similar to sowing V. 246 and V. 247 p. 382, but in two generations it has bred true to type. All the offspring were *nana*-individuals with narrow petals slightly longer than the sepals, but the absolute size of them was less than that of many *arvensis*. The time of development to the flowering stage is the same as *arvensis*', only about $1^1/_2$ month; considerably shorter than *tricolor*'s (about $2^1/_2$ months).

All the plants have been *mac* and faintly *labellata*. Regarding the colour of petals, segregation has taken place, but only in tricolor-colours: *pall* and *lut*. Apparently some of its characters caused it to be referred to *tricolor* and some to *arvensis*. A cytological investigation showed that it usually had 13 chromosomes (hapl.) as *tricolor* (fig. 9 *b*). But in some of the anthers the divisions were very irregular, and most of the pollen from these anthers degenerated. A rather regular interkinesis of this sort is shown in fig. 9 *a*. 2 chromosomes here are lost in the first division. Possibly all the irregular pollen degenerates and therefore the type can be constant. According to its chromosome number I regard it as a *tricolor*, but it was certainly established through a segregation after hybridization and it has inherited some of *tricolor*'s and some of *arvensis*' characters.

One of the bright yellow *tricolors* (*grand*, *lut*, *n.mac*), a well established type that only segregate the two types *pall*, *mac* and *lut*, *n.mac* shows similar irregularities in the reduction division. The chromosome number is 13 haploid, but in a few cases two chromosomes are expelled in the heterotypic division. Fig. 9 *c* shows the homotypic metaphasis in such a dyad. Each of the nuclear plates has 12 chromosomes, and between them are seen the two expelled chromosomes. Apparently there is some instability in the chromosome stock. The cause of this instability is probably a preceding cross. I assume that all the bright yellow *tricolors* descend from crosses between *tricolor* and *arvensis*.

V. Are all the genotypically conditioned Combinations (Isoreagents) to be regarded as "Species"?

In *Viola* there is a multitude of possible types. When crosses are possible and give fertile offspring, and when the variation is caused in this way, we may expect from time to time to find all the combinations of the characters realized. With the classification here adopted there is 2 . 2 . 2 . 3 . 3 . 6 . 2 . 2 . 2 . 2 . 2 . 3 . 2 . 2 . 2 . 2 . 2 . 2 . 2 = 5,308,416 possible combinations. But as there are more characters varying than the former (for instance broad petals and narrow petals, but difficult to distinguish from each other), there are still more combinations. The number of possibilities will increase very rapidly, when new varying characters are found, and in the same proportion the likelihood of

finding them all realized during ones life-time will decrease. It is practically impossible to make a classification of so many systematic units.

But many of the individuals are heterozygotes, their offspring is inconstant and therefore they have no systematic value, some will say. It is a mere assertion and only supported by custom, that constancy in offspring is the real standard for systematic value. The ecological value of characters as *prostrata*, *atropurpurea* and *caespitosa* is the same, whether they are heterozygotically or homozygotically realized. When the purpose is to classify the individuals, it is more to the point to take a standard that has some relation to the individual itself and not to its offspring. The identical reaction against the conditions is such a standard. All individuals reacting identically against the conditions are of the same ecological value.

On the other hand, even if we maintain constancy in offspring as the standard for systematic classification, almost the same number of systematic units are possible as when the reaction is taken as standard; however the units are possibly still more seldom realized. Furthermore my investigations show, that in *Viola* the homozygotic types are far more frequent in nature than might be expected, so that the difference between the two apprehensions is more of theoretical than of practical significance. In all cases we get a very large number of systematic units within *V. arvensis* and *V. tricolor*.

It is interesting to see how the systematists hitherto have dealt with a polymorphous species like *Viola*. WITTROCK (1896) has given about 40 sub-species, varieties, sub-varieties, forms and sub-forms. The diagnoses comprise nearly all the varying characters, and in most cases the varieties are based upon one or a few individuals. WITTROCK's varieties and forms, in most cases correspond with one of my 5,308,416 combinations, and it would be very fortunate if the same combination of all the characters was found once more, that is to say: there is the greatest possibility of finding one of the other 5,308,376 combinations that have no name. Such a division, on the one hand, is quite insufficient, but on the other we cannot reasonably divide all the earth's 140,000 "old" species into so many new species, each with a new name.

Moreover I have been able to recognize several of WITTROCK's

types as segregation products from *tricolor* × *arvensis*. Such segregation products are the following types (WITTROCK 1897):

V. arvensis Murr. **communis* Wittr. var. *gotlandica* Wittr. (table X, fig. 144—152).
**curtisepala* Wittr. (table XII, fig. 196—203; table XIII, fig. 220—224).
**sublilacina* Wittr. (table XII, fig. 182—195);
**sublilacina* var. *atropurpurascens* Wittr. (table XIII, fig. 216—218);
**striolata* Wittr. (table XII, fig. 204—205).

When WITTROCK supposed that he was able to recognize the parental varieties to some other spontaneous hybrids, he mentions, it is quite illusory.

This investigation shows how little reason there is in the modern splitting up of Linnean species. Had one of these systematists found my individual from Læsø with the curious emarginate, nearly laciniate lateral petals, its erect stature and narrow, deeply serrate (fig. 4 *b*, pag. 369), glaucous and fleshy leaves, I am sure he would have made a new species of it, especially as all the descendents were of the same type. This individual was made the original specimen, and all its characters were inserted in the diagnosis, both the palmate stipules, the long and incurved spur, the acuminate basal petal and the dark spot in front of the style. Now I caused the statistical investigation on the locality to be carried out (table II Z, Æ, Ø, pag. 381) and it showed that the character *emarginata* might be combined with different characters. Of the 16 combinations possible in table II, 15 were realized among 100 individuals, this being the total number investigated from these 3 populations. If a new species should be based upon each diverging character such a small locality as Læsø would increase the number of species very much, because the individuals cross, and the new character soon will be combined with a lot of all the earlier known characters.

Every one, who is engaged in plant-determination, knows the difficulties caused by the fact that most specimens only agree with the diagnosis in some of the characters. In critical plant groups as *Viola*, where hybrids and stabilized segregation products from crosses are frequent, not only within the species but between the different collective species too, it is in many cases quite im-

possible to place the individual, which is examined, under any of the described systematic units. The result of these difficulties is a multitude of new "species." The genus *Hieracium* is another instance hereof. The increase of "species" in this genus has been especially great in the last 15 years. The number of *Hieracium*-names embodidied in the main volume of Index Kewensis is about 1400. The increase has come as follows:

In supplementum	I,	anno	1896:	c. 900	species
—	II,	—	1901:	- 40	—
—	III,	—	1905:	- 40	—
—	IV,	—	1910:	- 1800	—
—	V,	—	1915:	- 1200	—

The number of "species" up to the year of 1915 was about 5000, but it increases rapidly from day to day. Most of the new "species" are Scandinavian. The diagnoses are very long and comprise a 40—50 characters each. And I am sure there are millions of "species" not yet described. In *Hieracium* each little character is fixed by apomixis, but there is no doubt (according to Rosenberg's and Ostenfeld's investigations) that the different types and the large variety is due to preceding crosses between older species. Apparently circumstances here are to some extent parallel to *Viola*.

It is quite clear that this course leads to chaos. On the other hand we cannot be content with the old division in species. In many accurate scientific investigations, for instance in the relation between the plants and the habitat, it is necessary to work with far smaller and more accurate limited systematic units than those of the old "Linnean" species. But for these investigations, where sometimes one and sometimes another combination of characters is needed, it is necessary to work with the single, genotypically conditioned characters and their combinations (i. e. the isoreagents), which can be placed in a schedule as the tables I and II (pag. 378 and 381). Millions of new names of species are not needed for that reason.

Even if we cannot state the reason for it, we feel sure that there is a reality behind the notion of the Linnean species, in the same manner as the genera are a reality. The Linnean species become a superior classification above the new "species" (varieties, microspecies and isoreagents) just as Genus is a superior class-

ification above Linnean Species. Therefore it is a confusion of ideas to co-ordinate the Species and the Microspecies by using the binar nomenclature for both. For many purposes we have no use for a finer classification than the Linnean species.

In order to prevent this confusion I advance the following

Propositions:

1. The notion Species shall be maintained in its Linnean significance but according to our present knowledge as a superior classification.
2. The Species in this significance, especially the critical ones, shall be critically revised with regard to the variation of the characters. New diagnoses shall be given; in these are embodied only the characters that distinguish the species from all other species of that genus. No varying characters are embodied in the diagnoses. In a list after the diagnoses, all the varying characters and the genotypically conditioned variations of these (similar to my list of *Viola*) are given.
3. The minor units shall, in order to distinguish them from the Linnean species, be named Microspecies (Ostenfeld 1921, p. 117) in the sense heritably fixed units, and Isoreagents (= combinations of genotypically conditioned characters), when only the reaction of the individuals themselves against the conditions is taken into consideration (Raunkiær 1918).

   The term Forma shall be applied as a designation of the variations caused by the external conditions solely (as for instance *Polygonum amphibium* L. f. *terrestre* and f. *natans*).
4. Ternar nomenclature shall be applied for the Microspecies and Isoreagents. Just as the name of the species involves the name of the genus too, the name of the microspecies shall involve both the name of the genus and that of the species. (Not *Hieracium marginelliceps* Dahlst. but *Hieracium silvaticum marginelliceps* Dahlst. and not *Viola maritima* Schweigg. but *Viola tricolor maritima* Schweigg.).

When the varying characters and the genotypically conditioned variations of these are given after the diagnosis, every one can

construct a system of Isoreagents from this list according to the special investigations for which he will use them.

The splitting up of Linnean species in new »species« has frequently been based upon accidental observations of deviating individuals which are described, instead of trying to make a perspicuous classification of the types within the species based upon studies in the extent and the cause of the variation and other questions in connection herewith. In many cases this result is due to the fact that these systematists either do not accept the consequences of, or are not fully familiar with all the results of modern biology. The systematist's investigations are so difficult, that it is needful that he uses all the resources at his disposal. At the investigation of the small systematic units within the single Linnean species he cannot be content with employing the old methods alone, which suited the classification of the Linnean species themselves so long ago.

VI. Must *Viola tricolor* and *arvensis* be regarded as two distinct Species?

During the last 200 years these two systematic units alternately have been regarded as two distinct species and as two minor units belonging to the same species.

As early as in 1745 Alb. Haller distinguished two species (Haller 1745). In Historia Plantarum Helvetiae (1769) he distinguishes the two species in the following way:

n. 568 (*V. tricolor Riv.*): "flore calyce duplo longiore."

n. 569 (*V. bicolor Riv.*): "flore calyce paulo majori."

Linné regarded them as one species (Species Plantarum 1753).

Murray (Prodr. Stirp. Gottingensium 1770) separates them under the names *V. tricolor* L. and *V. arvensis* Murr. (syn: *V. bicolor arvensis* C. Bauh.) and for description he refers to Haller's forenamed description of them both. — Most frequently they have been looked upon as two species.

I regard them as forming two species. If we assume the criterion of hybridization as the only criterion in all cases, they would not be so. They cross and produce fertile offspring. And moreover, there are smooth transitions between them. But then all the *Melanium* section would constitute one species. In *Viola*

the facts are so extraordinary, that I do not believe that the common rules are sufficient.

For following reasons I maintain them to be two species:

1. The chromosome numbers are very distinct: 13 and 17.
2. Two well defined types: *grand*, *lab*, *viol* and *parv*, *n.lab*, *albid* exist and are far more frequent than the transition types.
3. The two species, when crossed, cannot give segregation in Mendelian proportions owing to the difference in chromosome number and the irregular distribution of chromosomes in F_1.

VII. What is typical *V. tricolor* and typical *V. arvensis*?

I know no better distinction between the two species than HALLER's above quoted diagnoses: *grandiflora* = *tricolor* and *parviflora* = *arvensis*. But the dividing line between *grandiflora* and *parviflora* is not quite the same as HALLER's. According to general use I determinate *parviflora* (*arvensis* in widest sense) as all plants with the upper petals as long as or shorter than the upper sepal (including both the homozygotic *parviflora* and the intermediate heterozygotic *parviflora*) and *grandiflora* (*tricolor* in widest sense) as all plants with the upper petals longer than the upper sepal.

But when the question is what is typical *arvensis* and *tricolor* i. e. the probable combination of the original species, that crossed have produced the great multitude of types, we have no other guide than the frequency of the combinations in nature.

Looking at table I, pag. 378 we will find, when only the three first characters are considered, that one combination of *parviflora* is far more frequent than the three other combinations. This combination is *parv*, *albid*, *pinn* and must be considered as the typical arvensis. The other combinations are of unfrequent occurrence: *parv*, *albid*, *palm* and especially the two combinations *parv*, *viol* (*n.albid*) (only 46 individuals among 758).

Among the *grandiflora* individuals two of the four combinations are far more frequent than the remaining two. The combination *grand*, *albid* is very rare (only 12 individuals among 1142). The remaining 1130 individuals are all *grand*, *viol* (*n. albid*) but 449 have pinnate and 681 have palmate stipules. It is

a very wide spread opinion, that *tricolor* has pinnate stipules (BECKER 1905, pag. 48, about *tricolor:* "Stipulae pinnatifidae"), but I presume it is wrong. Palmate stipules are more frequent than pinnate. Many of the *tricolor* (*grandiflora*) individuals descend from crosses between *tricolor* and *arvensis* and I suppose that all the *tricolor* individuals with pinnate stipules are stabilized segregation products from these crosses. In other words: that the original typical *tricolors* had palmate and the original typical *arvensis* had pinnate stipules. If we had a territory with *tricolor* alone, the statistic proportion from this territory might decide the question. Such a territory we do not have, as *arvensis* occupies a territory being co-extensive with and extending beyond *tricolor*'s. When the facts are so, we must try to compare a territory where *tricolor* is far more common than *arvensis* with one where *arvensis* is just as frequent as *tricolor.* In Jutland we have such two territories. *V. tricolor* (*grand, viol*) is one of the most predominant plants in West-Jutland. In early summer the fields are blue with these flowers. In many of these fields I never saw an *arvensis.* In East-Jutland fields with *arvensis* alone alternate with fields with *tricolor* alone and with fields with both *arvensis* and *tricolor.* The following table gives the distribution of palmate and pinnate individuals among the *tricolors* in 7 habitats from West-Jutland and 7 habitats from East-Jutland:

			Number of individuals	%-tic relation
grand viol	West Jutland	*pinn*	178	29 %
		palm	432	71 %
	East Jutland	*pinn*	297	47 %
		palm	333	53 %

The table shows that in West-Jutland a far greater proportion of *tricolors* have palmate stipules than in East-Jutland and therefore I suppose palmate stipules to be typical of the pure *tricolor.*

As to the dark spot in front of the style it is rare in *parviflora* individuals and very frequent in *grandiflora* individuals and I suppose it to be a *tricolor*-character.

The characters that distinguish the typical *arvensis* from the typical *tricolor* are the following (the first named characters are the most significant):

Viola arvensis typica: parviflora stigma non labellatum, petala albida, stipulae pinnatifidae, stylus non maculatus.

Viola tricolor typica: grandiflora, stigma non labellatum, petala violacea (lutea, rosea, alba), stipulae palmatisectae, stylus maculatus.

Viola tricolor maritima (typica): Folia parva, carnosula, caules atropurpurei, caespitosi, prostrati.

VIII. Notes on the Geographical Distribution of *V. arvensis* and *V. tricolor* in Denmark.

On a journey through Jutland in early summer 1921, undertaken with the support from the Botanisk Rejsefond in order to examine the variation of the Danish *Viola*-species belonging to the *Melanium* section, I had occasion to make some observations concerning the distribution of the types.

One of my routes stretched from Aabenraa in Eastern South-Jutland to Flensborg Fjord. From here it ran across South-Jutland to Tonder and Hojer on the west coast. Further northwards along the coast to Hjerpsted and from here eastwards to Visby.

Another route stretched from Varde westwards through the heathery countries to the North Sea and northwards through the dunes along the coast and through the heathery countries to Nymindegab at the southern end of Ringkobing Fjord. From Ringkobing westwards through the fertile Holmsland between Ringkobing Fjord and Stadil Fjord and southwards through the sandy isthmus Holmsland Klit between Ringkøbing Fjord and the North Sea. Further northwards along the dunes almost to Nissum Fjord and eastwards to Ulfborg.

A third route stretched from Viborg through the reclaimed heathery territories in Mid-Jutland north eastwards to Hobro at the east coast and northwards to East-Himmerland, which is very abundant in lime. The lime in most places is very near to the surface of the ground, and at several places it juts out in lime-hills. Southwards again through East-Jutland via Hadsund to Randers and south-east to Kalo and Mols with the sandy

Mols Hills at Kalo Vig. Finally I visited the two islands Tuno and Samsø in Kattegat.

Along the first route in South-Jutland *V. tricolor* was the predominant of the two species. Only in the eastern part some *arvensis* were found. These *tricolors* were the most palmate ones I ever have found (population V, table I, pag. 379). Some of these (from Rode-Kro) had palmatilobate, broad-based, triangular stipules resembling *cornuta*'s and similar to the type BECKER has described from the Færoes as *V. tricolor* subsp. *færoensis* W. Becker in Bot. Færoes III 1907, pag. 856. No *maritima* types were found at the West coast by Emmerlev or Hjerpsted.

Along the second route through the heaths and dunes of West Jutland (populations P, Y, F table I, pag. 378, AA and BB table II pag. 381), *V. tricolor* was the all-predominant species. In my statistical schedules I have no *V. arvensis*. My intention was to study the *maritima* types here. South of Nyminde I found only one considerable population of *V. tricolor* in the dunes. It was at Børsmose mid-way between Blaavands Huk and Nyminde. They were *tricolor* individuals of the common type, only a little phenotypically altered in appearance by the extreme conditions. The leaves were not fleshy and the stems were normally green, *non atropurpurea*. No real *maritima* (*parvifoliata*, *carnosula*, *atropurpurea*) were found till Nyminde, where the population AA, table II, pag. 381, is from. All the individuals were *parvifol*, *carnosula*. Only 10 per cent were *n.atropurp*, the remaining were *atropurp*. From here to Ohuse south of Nissum Fjord (population BB, table II), where I left the dunes, *maritima* was very frequent and the only one living in the dunes, even if the typical *tricolor* grew in the fields on the other side of the road that separated the dunes from the fields. Most of these *maritima* were a little *acuminata* but this character was not so strongly marked as in those I found in 1919 in the dunes of Skagen (CLAUSEN 1921, pag. 210, population K). The point on the spur-bearing petal was very short.

The typical *maritima* lives also further south than Nyminde. From Fano I have received seeds of a true *parvifol*, *carnosula*, *atropurp*, *prostrata* type (leg. Professor WINGE).

In spite of the varying characters the *maritima* types from Fano, Nyminde-Nissum, Skagen and Læso have something in common: the small, narrow, glabrous, fleshy leaves, the narrow

sects of the stipules, the atropurpureous stems (often the nerves of the leaves are atropurpureous too), the narrow petals, the short appendices of sepals and the long spur. Usually they are cespitosely branched in the surface of the ground. As far as I have been able to examine the *maritima* types in exsiccates from other coasts both in Denmark, Sweden and Germany (The Baltic Sea) and from the Dutch, Belgian, French and British shores of the North Sea and the Channel they are rather different from the West Jutland type which is the most extreme of them all and likely the fittest type to the extreme conditions. It is, in fact, the West-Jutland type that LANGE describes and pictures in Flora Danica fasc. 45, pag. 4, plate 2647 under the name of *V. tricolor* (L.) var. *arenaria* (Sond.), but it is surely not this variety, which WITTROCK (1897, pag. 69) correctly remarks. The specimen pictured in Flora Danica is *acuminata*. — Each territory has its special composition, and apparently the Skagen type with its always prostrate stems with very long internodes and its very narrow, long and tapering petals, that gives it an appearance very strange in a *Viola*, is the most extreme of them all.

The route from Viborg to Hobro was characterized by a multitude of types and combinations (populations I, M, N, A, table I, pag. 378). It was one large genetic experiment arranged by nature. It was characteristic that in the first field east of Viborg, where I found *Viola tricolor*, I immediately saw that the type was somewhat different from the type in the West-Jutland fields. Soon I discovered a plant, which I recognized as a hybrid between *tricolor* and *arvensis*. Necessarily I then might expect to find *arvensis*, and really, I soon discovered several typical *arvensis*. In the same manner facts were from field to field. In East-Jutland, especially in East-Himmerland between Mariager Fjord and Limfjord, *arvensis* is the most common of the two Danish *Melanium* species. In many parts and many fields not one *tricolor* can be discovered, while *arvensis* is very common (populations C, D, E, table I). But in many places here, areas with *arvensis* alone (populations B, G, table I) alternate with areas with *tricolor* alone (populations L, R, table I) and with areas with them both and the intermediate type (populations H, J, K, O, table I). Apparently the two species meet in the middle of Jutland and cross together.

Upon Samso at Selvig I found a dune population (X, table

I); but it was not the typical West-Jutland *maritima*. The individuals were all *grandifol*, *n.atropurp*. The only *maritima* character, they were in possession of, was *caespitosa*. Finally the whole population had *pallida* petals. Both *tricolor* and *arvensis* lives on Samsø (populations S, U, table I).

IX. The Distribution after the Conditions of the Habitat.

One of the most interesting facts concerning the distribution of the isoreagents is that the isoreagents belonging to *V. tricolor maritima* (*parvifol.*, *carnosula*) have never been found in other places than the dunes.

Another interesting fact is the distribution of the isoreagents according to the degree of acidity in the soil. Previously Ferdinandsen (1918) has stated, that *V. tricolor* is acidophilous and he suggests its possible occurrence on ground that lacks lime to 86 per cent. The corresponding index for *V. arvensis* he states to be 40 per cent., so that this species should be faintly acidophobous. Ferdinandsen has recorded *tricolor* or *arvensis* from 31 of his statistic tables (31 habitats). He classifies the degree of acidity in the soil in the following classes: basic, faintly basic, neutral, neutral-faintly acid, and acid. In the basic classes only *arvensis* is found, in the classes neutral and faintly acid both *arvensis* and *tricolor* and in the acid class only *tricolor*. The following table shows the distribution of the habitats among the classes of acidity:

Classes of acidity		Reaction of soil				
		basic	faintly basic	neutral	neutral-faintly acid	acid
Number of habitats with	*arvensis*	7	3	8	5	
	tricolor			1	4	4

Primarily it was not my intention to examine this question. Therefore I was not prepared for a more detailed investigation. But, during my journey, I observed that the distribution was so characteristic that even a rather rough determination of the degree of acidity might suffice to give a result. I applied litmus paper, hence only a rough classification in basic, neutral and acid was obtained. But this classification agrees with the general

impression of the habitat, and it also coincides with the results that might be expected from the geological structure of the ground on the habitats.

In table I, pag. 378, the habitats are arranged according to the degree of acidity in the soil: basic, neutral, acid; 3 habitats that only gave a very faintly acid reaction are inserted in a special class.

When the habitats F, T and U are excepted, the isoreagents are distributed as follows:

On basic ground: *parv*, *albid* (pure *arvensis*), populations A—E.
On acid ground: *grand*, *viol* (pure *tricolor*), populations P—S.
On neutral-faintly acid ground: all the combinations: *parv*, *albid*; *parv*, *viol*; *grand*, *albid* and *grand*, *viol* (pure *arvensis* and pure *tricolor* and the intermediate combinations), populations G—O.

This result is in accordance with FERDINANDSEN's above mentioned.

The cause of the many types present on neutral—faintly acid soil is certainly that both the extreme combinations (*arvensis* and *tricolor*) meet on this soil, and therefore there is a possibility of crosses.

Even if the reaction of the soil is not the only distributing factor, it is surely one of the most important. The geographical distribution of *arvensis* and *tricolor* in Jutland is certainly rather due to the reaction of the soil in East- and West-Jutland than to any special geographical causes. This is evident from the fact that the composition of the populations can change within very restricted areas parallel to the changes in the reaction of the soil. A diagram of the route from Viborg to Hobro will show it:

[faintly acid] [neutral] [faintly acid] [basic] [faintly acid]

M ⟶ I ⟶ N ⟶ A ⟶ A_1 (not in table I).

[*parv, albid* — *grand, viol* and intermediates] [*parv, albid* alone] [all combinations]

At Onsild (A) the populations suddenly changed. All the large blue flowers disappeared coinciding with the fact that seed and grass became markedly more vigorous. The explanation of

this sudden change was a marle stratum. The diameter of this basic oasis was not more than about 3 km, and coinciding with the fact that the soil had become acid again the large blue flowers reappeared (A_1).

Another striking change was observed in Himmerland, as the following diagram will show:

[basic] [neutral] [faintly acid]

C ——→ E ——→ D ——→ H ——→ J ——→ O

[*parv*, *albid* alone] [all combinations]

The distance between D (Bælum) and H (near Vorgaard) was not more than about 1 km, but the populations C—E—D were from the high lime districts and the populations H—J—O from the sandy valley of one of the rivers from the glacial period. I was not aware of this boundary line before *Viola* itself reminded me of it when I saw the large, blue flowers again.

I do not believe that the cause of this distribution is, that *tricolor* is incapable of growing in basic soil and *arvensis* incapable of growing in acid soil. But plants that react upon the degree of acidity have an optimum at which they become most vigorous (Carsten Olsen 1921), at other concentrations of p_H. they become more weak. Apparently *arvensis* has its optimum in the basic or neutral soil and *tricolor* in the acid soil. The strong competition in nature then causes that they usually only can pull through when the reaction of the soil approaches the optimum for the species in question.

There are 3 exceptions in table I (pag. 378). The population F with *grand*, *viol* on basic soil and T and U with *parv*, *albid* on acid soil. When the number of exceptions is so relatively large, it has its natural explanation in the fact that I have selected those populations which I suspected would deviate from the rule. The population F is from Holmsland (not Holmsland Klit) between Ringkobing Fjord and Stadil Fjord. It is a fertile basic oasis with loamy soil in the West-Jutland acid and sandy heath land. There is marle on Holmsland. Seed and grass was very vigorous, likewise *Viola*. I did not succeed in finding one *arvensis* here.

The population T is from a stony rye field near the harbour

of Tunø. Only *parv*, *albid* was found here. These plants were particularly vigorous; but the rye was weak and the soil distinctly acid. I have never seen *Viola* with a larger assimilating surface than these individuals. This fact was due to both the large leaves and the extraordinarily large stipules. Leaf and stipules of one of these plants is pictured in fig. 1 *e*, pag. 365. I presume that these *arvensis* descended from stabilized segregation products of crosses between *tricolor* and *arvensis*. *V. tricolor* lives on the island too. The chromosome number was the usual in *arvensis*, namely 17, and the divisions were regular (fig. 6 *a*, pag. 385).

Population U is from a sandy grass field at Koldby Kaas on the island Samsø. The soil was distinctly acid and the grass sparse. Only *parv*, *albid* was found and but few. In contradistinction from the specimens from population T they belonged to a small dwarf type. A characteristic feature was, that 13 of the 14 plants had palmatisect stipules as *tricolor*. Fig. 4 *a*, pag. 369 shows leaf, stipules and flower of offspring of one of these individuals, cultivated in the Botanical Garden this year. All the offspring was dwarf and palmatisect. The chromosome number is not determined yet. I am quite sure that this *arvensis* type is a segregation product from a cross between *arvensis* and *tricolor*.

The "sentiment", if we may say so, of an individual against the degree of acidity in the soil is a physiological character possibly contingent on one or more factors. Usually these factors are coupled with the factors that stipulate the size and the colour of the petals. The two species have a different optimum as to the degree of acidity, *arvensis* at a high p_H-value and *tricolor* at a lower one. It is not likely that these factors for a certain optimum should be coupled absolutely with the factors for the morphological characters. When the two species cross, we therefore should expect to get *arvensis* types (*parv*, *albid*) with optimum at a low p_H. (acidophil) and *tricolor* types (*grand*, *viol*) with optimum at a high p_H. (acidophob.) In some cases the preceding recombination of factors is manifested by the fact, that a morphological character has been separated from the complex of characters it usually is connected with. Such is apparently the case with the population U, where the character *palmata* together with the character *acidophilous* have possibly become separated from the character-complex *grand*, *viol* and instead have been connected with the character-complex *parv*, *albid*.

In other cases, as in the population F from Holmsland, no external signs of a preceding cross and recombination have been found, but there can be no objection to that supposition that a factor for optimum at a high p_H.-value might cross over to the factor-complex for *grand*, *viol* without being accompanied by factors for morphological characters, so that the explanation, also in this case, can be a preceding cross between *tricolor* and *arvensis* with the following recombination of factors.

X. Adaptation as a Result of Mutation, Crosses and Selection.

In a short paper TURESSON (1922) has shown that some so-called "adaptative" types inhabit certain localities, so that the re-appearance of a distinct locality coincides with the re-appearance of the variety typical to that locality. This fact is most strikingly shown in *Hieracium umbellatum*. In the south-eastern corner of Skåne (Sweden) woods, dunes and sand-fields alternate within short distances. The woods are inhabited by an erect broad-leaved type, the dunes by a lesser erect, more narrow-leaved and strongly shoot-regenerating type; in the sand-fields grows a prostrate, hirsute type. Where woodland is replaced by dunes, the woodland varieties are replaced by the dune varieties and these in their turn are replaced by the prostrate types when the sand-fields begin. At the boundary line between two of these zones a narrow zone inhabited by all kinds of intermediate types can be found. — The same applies to three *Atriplex*-types. The east coast of South-Sweden is inhabited by one type, the west coast along the sound by another and north of the sound on the exposed west coast lives a more deviating, small-leaved, prostrate type. On the whole TURESSON found a parallelism between the extremeness of type and the extremeness of locality. He supposes the varieties differentiated from previously existing types and their combinations when crossed.

The parallelism between these *Hieracium*- and *Atriplex*-types and the extreme West-Jutland types of *Viola* is striking. Certain populations are composed by isoreagents which are ecologically "adapted" to the conditions of the habitat. In the vagabondizing *Viola* populations on cultivated ground such an adaptation is of course not so pronounced. These populations do not live so long at the same place that they can become balanced. But

in the dune populations an accordance to the extreme conditions can be recognized: in the small transpiration surfaces of the leaves, in the somewhat fleshy leaves, in the large and deep going roots, in the plentiful anthocyanin in stems and leaves, in the extensive ramification in the earth's crust, by which they become perennial, and in the transversely geotropic stems, they exhibit genotypically conditioned characters that are of great importance to the plants at these localities.

The older Lamarckian interpretation regarded these "adaptations" as a direct effect of the extreme conditions. The Selectionism saw an effect of the continued selection between the fluctuating variations. That there is a fitness to function cannot be denied. The question is merely in which way it has come into existence.

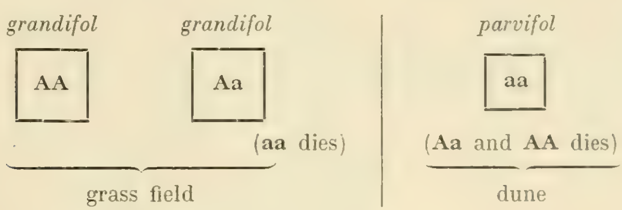
The selection cannot create new types (JOHANNSEN) but it can select the fittest among already existing types or among types that arise after crosses, in other words: it can select the fittest combinations of the existing genes, but it cannot create new genes.

As to the supposed direct effect of the conditions, we neither have been able to trace such an effect nor disprove it. It agrees badly with our present apprehensions concerning genotypic structures and genotypic constancy. The only instance we know of genotypic inconstancy is the mutations. In which way they take place and by which influences they are induced we do not know. And as to the nature of mutations we know nothing. The only way in which we might suppose that the conditions could act upon the genotypic structure is through the mutations, either by increasing the number of mutations or by affecting the direction of the mutations.

But we need not a supposition of a direct effect of the external conditions to explain the parallelism between the extremeness of type and the extremeness of locality. This might be explained as an effect of mutation, crosses and selection solely. The mutations, crosses and segregations mainly provide the material for the selection, and the selection itself brings about the "adaptation". Occasionally, crosses between different species occur and supply one species with a character from another that enables it to live in places, where it previously could not live. In *Viola tricolor* and *arvensis* this is unusually frequent (*tricolor* on basic soil and *arvensis* on acid soil).

When the existing and not yet existing but possible hereditary different types are as many as in *V. arvensis—tricolor*, the selection has a large material to act upon, and by and by, eliminates the least fit types.

The West-Jutland dune types are in the character *parvifoliata* recessive to the common *grandifoliata* types. Likely the *parvifoliata* originally came into existence by a mutation in a place far from the dunes. This character is not profitable in places, where the transpiration is normal. But as the factor for it is recessive, it can "emigrate concealed" (Raunkiær 1920, pag. 4) heterozygotic, even if all the homozygotic parvifoliate individuals die before they can disperse seeds. When it reaches to a locality, where the character induced by this factor is profitable, it becomes homozygotic by elimination of both the heterozygotic and homozygotic grandifoliate individuals. If **A** is the factor for *grandifol* and **a** the factor for *parvifol* the circumstances might be illustrated by the following diagram:



aa cannot live in the grass field owing to the strong competition there. **Aa** and **AA** cannot live in the dunes because of the strong transpiration there. Therefore these two isoreagents do not intrude on each others territories. Even if they cross at the boundaries, the type not fit to the conditions is eliminated. Only in this way the aforementioned peculiar circumstances at Holmsland Klit (pag. 375, fig. 5 *a* and *b*) can be explained.

Stabilization of conditions in a place will certainly, by and by, cause the isoreagents fit to the conditions at the spot in question, to become more and more homozygotic; those with the recessive characters first, but also those with the favourable dominant characters, as all the recessive here have gradually been eliminated when they are segregated. The heterozygotes themselves decrease in proportion to the dominant homozygotes unless the first should be better fit to live than the latter. Accord-

ing to this it will be understood why so many types from nature are pure in the essential characters and show no segregation. Probably the homozygotes are far more common in nature than originally supposed.

The principal cultivation experiments were carried out in the Botanical Garden of the University, Copenhagen. The cytological investigations were carried out in the Laboratory of Genetics of the Royal Veterinary and Agricultural College, Copenhagen, and some of the cultivation experiments from 1922 here mentioned took place at its experimental field at Lyngby. I tender my best thanks to Professor RAUNKIÆR, Director of the Botanical Garden, and to Professor WINGE Phil. Dr., Director of the Laboratory of Genetics, for the kindness with which they have placed these institutions at my disposal.

I thank the "Botanisk Rejsefond" for the kindly aid given me for my statistical and ecological investigations in nature, especially in Jutland, and I thank Mr. C. A. JORGENSEN for his kindness in making the three lists from Læsø.

Copenhagen, the Botanical Museum of the University. 4/9. 1922.

Literature.

Becker, W., (1904): Systematische Behandlung der *Viola arvensis* auf Grundlage unserer phylogenetischen Kenntnisse. (Mitt. des thüring. bot. Vereins. Neue Folge XIX. Heft 19). — Weimar.

Clausen, J., (1921): Studies on the Collective Species *Viola tricolor* L. (Preliminary Notes). (Bot. Tidsskr. Bd. 37). — København.

Ferdinandsen, C., (1918): Undersogelser over danske Ukrudtsformationer paa Mineraljorder. — København.

Flora Danica, Vol. XV. Fasc. 45.

Haller, Alb., (1745): Flora Jenensis. — Jena.

— (1769): Nomenclator ex Historia Plantarum indigenarum Helvetiae. — Bern.

Linné, C., (1753): Species Plantarum. — Stockholm.

Murray, A., (1770): Prodr. designationis Stirpium Gottingensium. — Goettingen.

Nachtsheim, H., (1921): Die Gründung der Deutschen Gesellschaft für Vererbungswissenschaft. (Die Naturwissenschaften. Heft 22). — Berlin.

Olsen, C., (1921): Studier over Jordbundens Brintionkoncentration og dens Betydning for Vegetationen, særlig for Plantefordelingen. (Compt. rend. trav. Laborat. Carlsberg. Vol. 15). — København.

Ostenfeld, C. H., (1921): Some experiments on the origin of new forms in the genus *Hieracium*. (Journal of Genetics. Vol. XV). — Cambridge.

Raunkiær, C., (1889): Vesterhavets Ost- og Sydkysts Vegetation. — København.

— (1918): Ueber den Begriff der Elementarart im Lichte der modernen Erblichkeitsforschung. (Zeitschr. f. ind. Abst. und Vererbungslehre. Bd. 19). — Berlin.

— (1920): Erindringsord til Forelæsninger over Plantegeografi. — København.

Turesson, G., (1922): The Species and the Variety as ecological units. (Hereditas III). — Lund.

Wittrock, B. V., (1897): *Viola*-Studier I. (Acta Horti Bergiani, Bd. 2, Nr. 1). — Stockholm.

Studier over Samlearten Viola tricolor L. II.

Resumé

af

J. Clausen.

I. I Fortsættelse af den foreløbige Meddelelse i nærværende Binds 3die Hefte om de varierende Karakterer hos *Viola tricolor* — *arvensis* skal her gives en Meddelelse om en Del yderligere varierende Karakterer:

6. Kronbladfarve:
   Hos typisk *arvensis*: gulhvid (*albid*).
   Hos typisk *tricolor* følgende Farver:
   blaa (*viol*), højgul (*lut*), rosa ell. rødlila (*rosea*), blegblaa (*pall*) og ren hvid (*alba*).
7. Sporelængde:
   langsporet (*long.calc*): Sporelængden mere end 2 Gange Bægerbladenes Vedhæng; hos Klit-Typer (Fig. 1 *c*, S. 365).
   kortsporet (*brev.calc*): Sporelængden ikke mere end 2 Gange Bægerbladenes Vedhæng.
8. Sporeform:
   krumsporet (*incurv.calc*): hyppigst hos langsporede.
   retsporet (*rect.calc*).
9. Formen af det sporebærende Kronblad:
   tilspidset (*acum*): Fig. 2 S. 367; hos vestjydske og læsøske Klittyper.
   ikke tilspidset (*n.acum*): Fig. 1 *b*, S. 365; den almindeligste Form.
10. Sidekronblade:
   udrandede — svagt fligede (*emarg*): Fig. 2; findes kun paa Læsø; muligvis ingen andre Steder i Verden;
   hele (*integ*): den almindelige Type.

11. Kronbladenes Overflade:
    fløjlsagtig (*velut*): er foraarsaget ved, at de Vorter, hvortil Kronbladenes Overhudsceller er udtrukne, er særlig tætte og kraftige (Fig. 3 *a*, S. 368); denne Karakter kan ogsaa findes hos vildtvoksende *V. tricolor*.
    ikke fløjlsagtig (*n.velut*): det almindeligste.
12. Støvkornene, der i fugtig Tilstand set ovenfra er enten:
    hovedsagelig firkantede (Fig. 3 *d*): *tricolor*,
    hovedsagelig femkantede (Fig. 3 *e*): *arvensis* eller
    omtrent lige mange fir- og femkantede.
    Mellem de firkantede kan findes enkelte trekantede (Fig. 3 *c*) og mellem de femkantede enkelte sekskantede (Fig. 3 *f*). Set fra Kanten er alle Støvkornene som Fig. 3 *b*.
13. Bladstørrelse:
    smaabladede (*parvifoliata*): Fig. 1 *c*, S. 365 og 4 *b*, S. 369. En Type fra Klitter; de smaabladede er vistnok altid tillige noget kødfulde;
    Blade af normal Type (*grandifoliata*): Fig. 1 *a* og *b* og Fig. 4 *c*. Bladfladen er 3—4 Gange større end hos de smaabladede Klittyper. Bladene er ikke kødfulde.
14. Bladform:
    ægformede, rundtakkede (*ovat-cren*): (Fig. 1 *a*): hos *arvensis*;
    lancetformede, savtakkede (*lanc-serr*), (Fig. 1 *b*): hos *tricolor*.
15. Akselblade:
    fjerdelte (*pinn*): hos *arvensis* (Fig. 1 *a*);
    haanddelte (*palm*): hos *tricolor* (Fig. 1 *b*).
16. Akselblades Midtflig:
    løvbladagtig udvidet (*foliac*): Fig. 1 *d* og *e*. (Midtfligen takket).
    ikke løvbladagtig udvidet (*n.foliac*): Fig. 4 *a*, *b* og *c*, S. 369.
17. Vækstform:
    nedliggende Stængler (*prostr*): alle Stængler er transversalt geotropiske (Fig. 5 *b* og *c*, S. 371). Findes mest i de vestjydske Klitter.
    oprette Stængler (*erect*): Hovedstænglen er negativt geotropisk (Fig. 5 *a*). Det almindeligste Tilfælde.
18. Stængelfarve:
    anthocyanrøde Stængler (*atrop*): findes mest i Klitter;
    frisk grønne Stængler (*n.atrop*).
19. Levetid:
    fleraarige, d. v. s. tueformet forgrenede i Jordskorpen (*caesp*): en Karakter, der findes hos de fleste vestjydske og læsøske Klittyper (Fig. 5 *b*). Ofte 20—50 Sidegrene i Jordskorpen.
    enaarige, ikke tueformet forgrenede (*n.caesp*): kun Sidegrene ovenfor Jordskorpen.

Flere af disse Karakterer griber ind over hinanden og er derfor undertiden vanskelige at skelne fra hinanden.

II. Disse forskellige her nævnte Variationer er arveligt forskellige. Et af de mest slaaende Eksempler herpaa afgiver Planterne paa Fig. 5, S. 371.

De to Planter er begge fra S. Lyngvig paa Holmsland Klit. 5 *a* er fra en Græsmark paa Tangens mere leragtige Inderside og 5 *b* er fra Klitten paa den anden Side af Vejen, der skiller Mark og Klit fra hinanden. 5 *a* var opret, storbladet, friskgrøn, enaarig, medens 5 *b* var nedliggende, smaabladet, anthocyanrød, fleraarig altsaa altsammen Egenskaber, der kan have Betydning for Planter, der lever i Klitter. Alle Planterne paa Marken var af Type som 5 *a* (Bestand Y, Tabel I, S. 379) og alle fra Klitten som 5 *b* (Bestand BB, Tabel II, S. 381). Og dog var det ikke Modifikationer fremkaldt af de meget forskellige ydre Kaar, men virkelig arvelige Forskelligheder betingede af indre Anlæg. Afkom af disse 2 Planter blev nemlig dyrket i Bot. Have under samme Kaar, og desuagtet bibeholdt det Forskellighederne, idet alt Afkommet fra Marken blev af Type som 5 *a* og alt fra Klitten af Type som 5 *b*.

III. Saa langt som jeg har kunnet undersøge, har det vist sig, at alle Kombinationer af de omtalte Variationer er mulige, men de er langtfra lige hyppige allesammen.

Tabel I, S. 378 giver Resultatet fra 23 Voksesteder A—Y hovedsagelig fra Jylland. Der er taget Hensyn til 4 Karakterer, nemlig:

Kronbladstørrelse: smaakronet (*parv*) og storkronet (*grand*).

Kronbladfarve: gulhvid (*albid*) og blaa (*viol*) (inclusive de andre *tricolor*-Farver).

Akselblade: fjerdelte (*pinn*) og haanddelte (*palm*).

Akselblades Midtflig: lovbladagtig (*foliac*) og ikke lovbladagtig (*n.foliac*).

De paa et Voksested fundne Kombinationer af disse 4 Karakterer er beregnet pr. 100 Individer.

Tabel II, S. 381 viser paa lignende Maade Kombinationerne mellem nogle Karakterer, der er typiske for Klitplanterne: Voksestederne Z—Ø er fra Læsø, AA og BB fra Klitter i Vestjylland. Alle Planterne er storkronede, men de varierer iøvrigt i:

Akselblade: fjerdelte (*pinn*) og haanddelte (*palm*).

Sporelængde: kortsporet (*brev.calc*) og langsporet (*long.calc*).

Sporeform: retsporet (*rect*) og krumsporet (*incurv*).

Sidekronblade: helrandede (*integ*) og udrandede (*emarg*).

Forneden er der angivet den procentvise Mængde af Planter med tilspidset nedre Kronblad (*acum*). For Bestandene AA og BB er kun angivet Akselblade, Sporelængde og Stængelfarve: frisk grøn (*n.atrop*) og anthocyanrød (*atrop*).

Begge Tabellerne viser, at saa godt som alle Kombinationer er fundet realiseret.

IV. De mange i Naturen forekommende Typer hørende til *V. tricolor* eller *arvensis*, stammer fra Krydsninger mellem *tricolor* og *arvensis* og mellem disse Krydsningers Udspaltningsprodukter.

De stærkt blandede Bestande i Naturen som i Tabel I: H, I, J, K, M, N og O er saadanne Udspaltninger, og Planter fra saadanne Bestande spalter yderligere. Tabel III, S. 382 viser de Typer, der fremkom af to

smaablomstrede, blaablomstrede Planter (*parv*, *n.lab*, *viol*, *mac*) V. 246 og V. 247 fra Bestand F, Tabel III, Frederikshavn 1919.

Ved kunstig Krydsning af *V. arvensis* med *V. tricolor* faas der i 2den Generation en Udspaltning af Typer, der ganske ligner Typerne fra de omtalte, stærkt blandede Bestande fra Naturen.

Endelig viser Cellekærnens Delingsforhold hos de formodede Bastarder i Naturen fuldstændig Overensstemmelse med Delingerne hos de kunstigt dannede Bastarder. *V. tricolor* (*grand*, *viol*) har 13 Kromosomer (Fig. 6 *b*, S. 385) og *arvensis* (*parv*, *albid*) har 17 (Fig. 6 *a*). Bastarderne derimod viser alle mulige Tal fra 13 til 17 i samme Støvsæk. Fig. 7 *a*—*g* og 8 *a*—*e*, S. 385, 389 er Afbildninger af Delingerne i en frivillig Bastard fra Naturen (*parv*, *lu* fra V. 246, Tabel III, S. 382) og Fig. 7 *h* og 8 *f* er de tilsvarende Figurer af kunstige Bastarder. Som det ses, er der meget stor Overensstemmelse.

V. De Smaa-Arter, som WITTROCK (1897) har beskrevet, er opstillet paa de foran omtalte varierende Karakterer. Da der med den Inddeling, jeg har anvendt, er 5,308,416 Kombinationer mulige, skal der et rent Held til at faa fat i en af de 40, som WITTROCK har beskrevet. Der er langt større Chance for at faa fat i en af de andre 5,308,376 Kombinationer. WITTROCK's Smaa-Arter kan genkendes som Bastardudspaltninger.

Det store Antal Muligheder viser, at man ligesaa godt kan holde op med at opstille Smaa-Arter indenfor de kritiske Arter paa den hidtil anvendte Maade, hvor alle Karakterer tages med i Diagnosen. Dersom man skal naa til Bunden paa den Maade, kommer man snart op paa et Antal af Smaa-Arter, der gør det umuligt for et Menneske indenfor sin egen Levetid at undersøge blot et Individ af hver af de mulige Kombinationer indenfor en enkelt Art.

Til mere detaillerede økologiske Undersøgelser kan man ikke nøjes med den gamle linnéske Artsinddeling, men maa skelne mellem langt mindre systematiske Enheder. Til dette Brug kan man mest rationelt arbejde med selve Karaktererne (de anlægsbetingede) og deres Kombinationer (Isoreagenterne) stillet op i et Kombinationsskema som Tabel I og II. Derved kan man nøjes med et langt mere begrænset Antal Navne. (De 5,308,416 omtalte *Viola*-Kombinationer kan udtrykkes ved at anvende 45 forskellige Variationer af Karakterer. Som Regel har man Brug for et mindre Antal Karakterer).

VI. Skønt *V. tricolor* og *arvensis* krydses og frembringer frugtbart Afkom, betragter jeg dem som to veldefinerede Arter. Der eksisterer nemlig 2 Typer: *parv*, *n.lab*, *albid* (*arvensis*) og *grand*, *lab*, *viol* (*tricolor*), der er langt hyppigere end Mellemtyperne (Tabel I); svarende dertil er 2 Kromosomtal, 17 og 13, langt hyppigere end de andre mellemliggende Tal, der ogsaa synes at være forbundet med Uregelmæssigheder ved Delingerne.

VII. Dersom *V. tricolor* — *arvensis* skal deles i 2 Grupper paa en saadan Maade, at ethvert Individ, der træffes, kan komme ind under enten den ene eller den anden Gruppe, bør man anvende Kronbladstørrelsen som eneste Skelnemærke, saaledes at alle smaablomstrede (*parv*) henføres til *arvensis* og alle storblomstrede (*grand*) henføres til *tricolor*. Dette stemmer med MURRAY's (1770) og HALLER's (1769) Diagnoser.

Dersom der derimod er Tale om de typiske Arter, kan man nok tage flere Karakterer med, og da følgende:

Typisk *V. arvensis*: smaablomstret, Støvfang uden Læbe, Kronblade gulhvide, Akselblade fjerfligede, Griffel uden Plet paa Forsiden.

Typisk *V. tricolor*: storblomstret, Støvfang med Læbe, Kronblade blaa (højgule, rosa ell. rent hvide), Akselblade haandsnitdelte, Griffel med mørk Plet paa Forsiden.

Typisk *V. tricolor maritima*: som *V. tricolor*, men desuden: Blade smaa, noget kødfulde, Stænglerne anthocyanrøde, tueformet forgrenede, nedliggende.

VIII. I Vestjylland (Bestandene F, P, Y, Tabel I) er *V. tricolor* langt den almindeligste af de 2 Arter, og i Klitbæltet er den saa godt som udelukkende af *maritima*-Typen (AA og BB, Tabel II). I Østjylland, specielt i det kalkrige Øst-Himmerland, er *arvensis* den almindeligste Art (C, D, E, Tabel I), selv om ogsaa Marker med *arvensis* alene (B, G, Tabel I) veksler med Marker med *tricolor* alene (L, R, Tabel I) og med Marker med begge Arterne — Mellemtyperne (H, J, K, O, Tabel I). I Midtjylland mødes de to Arter og krydses med hinanden som Bestandene I, M og N, Tabel I, viser.

IX. Fordelingen efter Voksestedets Kaar. Det er karakteristisk, at *V. tricolor maritima* (d. v. s. den fleraarige Type med smaa, kødfulde Blade) udelukkende bebor Vestkystens og Læsøs udsatte Klitbælter. Den Type, der vokser i Vestjylland, er forskellig fra de Typer, der vokser ved Østersøens Kyster og ved de engelske, franske, belgiske og nordtyske Kyster af Vesterhavet og Kanalen. Den vestjydske Type er den mest udprægede af dem alle med dens smaa, smalle, glatte og noget kødfulde Blade, Akselbladenes smalle Afsnit, de anthocyanrøde Stængler, de smalle Kronblade, Bægerbladenes korte Vedhæng og den lange Spore. Naar dertil kommer den overordentlig stærke Forgrening i Jordskorpen, de ofte transversalt geotropiske Stængler med meget lange Stængelled og det i en lang Spids nedløbende sporebærende Kronblad hos nogle af Typerne, vil man forstaa, at de er meget afvigende fra andre *Viola tricolor*. At de fleste af disse Karakterer er gunstige paa disse udsatte Steder med den stærke Blæst og den stærke Fordampning er sikkert nok, og *maritima*-Typerne frembyder saaledes et meget smukt Eksempel paa den Parallelisme, der ofte findes mellem Særprægethed i Kaar og Særprægethed i Vegetationstype. Disse ejendommelige Typer findes fra Nymindegab til Skagen, paa Fanø og paa Nordsiden af Læsø. Den mest særprægede af dem alle er sikkert Skagen-Typen.

Forøvrigt har Undersøgelsen vist, at Fordelingen af *tricolor* og *arvensis* i Jylland snarere er betinget af Jordens Surhedsgrad end af specielle geografiske Aarsager. De forskellige Typer fordeler sig paa følgende Maade:

Paa alkalisk Bund: *parv*, *albid* (= ren *arvensis*): Bestandene A—E, Tabel I.

Paa sur Bund: *grand*, *viol* (= ren *tricolor*); Bestandene P—S, Tabel I.

Paa neutral, svagt sur Bund: alle Kombinationerne: *parv, albid*; *parv, viol; grand, albid* og *grand, viol* (ren *arvensis*, ren *tricolor* og alle Mellemtyperne); Bestandene G—O, Tabel I.

De tre Undtagelser, Bestandene F, T og U, har antagelig deres Aarsag i en foregaaende Krydsning, hvorved Faktorerne for Evnen til at trives godt paa Surbund eller alkalisk Bund er blevet kombineret med Faktorerne for andre morfologiske Karakterer end de, som de plejer at være kombinerede med.

X. Den Overensstemmelse der findes mellem Særprægethed i Kaar og Særprægethed i Vegetationstype behøver ikke at være foraarsaget ved, at Kaarene kan ændre Typerne, ja det er sandsynligt, at Kaarene ingen Indflydelse har i saa Henseende. For at forklare Overensstemmelsen behøver man heller ikke at ty til denne Mulighed, idet den kan forklares ved Antagelsen om Mutationer, Krydsninger med paafølgende Udspaltninger og det derpaa følgende naturlige Udvalg mellem de herved fremkomne Typer. Disse Virksomheder vil bevirke, at paa et Voksested med stabiliserede Kaar vil Typerne efterhaanden komme i Ligevægt, idet de mindst egnede udskydes, og de vil tillige bevirke, at Typerne paa saadanne Voksesteder vil blive arveligt konstante med Hensyn til de Karakterer, der har Betydning for dem i Konkurrencen paa disse Steder.

Contents.

Bianco Lunos Bogtr. Kbhvn.

Særtryk af Botanisk Tidsskrift. 37. Binds 5. Hefte. 1922.

Heleococcum aurantiacum n. gen. et n. spec.

By

C. A. Jørgensen.

In the autumn of the year 1921 Prof. L. KOLDERUP ROSENVINGE observed on a sample, which he had collected in the moor in the botanical gardens of the University of Copenhagen, some small globular perithecia of a fungus he did not know.

As we did not succeed in finding it mentioned in the mycological text-books (Schroeter, Rabenhorst, Clements), the fungus was handed to me for close examination in order to determine it by means of the existing literature on this subject.

In spite of a careful examination of the species described within the section of the mycology (Plectascineæ-Perisporiales), where the present fungus according to its structure must be referred to, I have not succeeded in finding any suitable diagnosis of a genus with which it agrees.

It seems therefore, that the fungus is not hitherto described, and even if the possibility is not excluded that a suitable diagnosis is to be found somewhere in the literature, I feel justified in describing the fungus as new to science, on the basis of the afore mentioned resultless investigations.

Heleococcum aurantiacum nov. gen. et n. spec. Perithecia superficialia, globosa, $^1/_2$—$^1/_3$ mm diam., primo albida, dein aurantiaca, peridio subtile, membranaceo, pseudoparenchymatico, ex 4—6 stratis cellularibus formato, glabro, areolato, ostiolo nullo, sporis maceratione peridii liberatis; ascis globosis, sessilibus, numerosis, sine ordine collocatis, paraphysibus nullis; sporis hyalinis, uniseptatis, ellipsoideis, membrana crassiori, glabra, 25—30 μ long., 10—15 μ lat. (Fig. 1 a, b, c & d). Habitat in solo humido horti botanici Hafniensis.

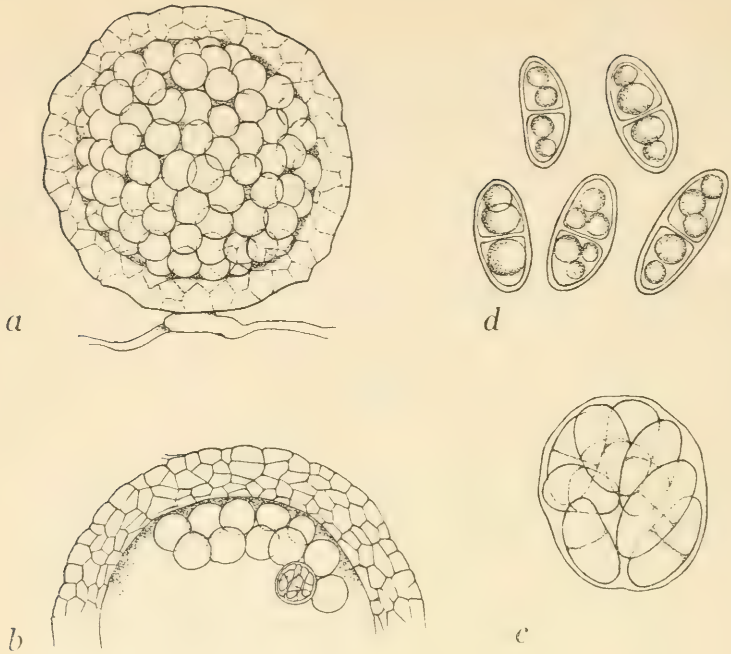


Fig. 1.
a) A ripe perithecium (× 110). *b)* median section through the same (× 110).
c) An ascus (× 650). *d)* Ascospores (× 650).

Among the already described species *Testudina terrestris* Bizzozero approaches nearest to Heleococcum. They are alike in having globular perithecia with an areolated surface; the asci, which contain 8 two-locular spores, are in both forms globular and lie promiscuously within the perithecium and conidia lack in both species.

Testudina differs from Heleococcum in its dark perithecia and spores but its special characteristic is, that the spores are liberated by the disintegration of the peridium into small polygonous fragments. It also differs as to the size of the spores and the spores of Testudina have a rugged surface. The most characteristic feature of the genus Heleococcum is the large, smooth, orange-coloured two-celled spores and the light colour of the perithecium; the spores are liberated by the disintegration of the peridium. The colour of the perithecium is localized in the wall of the spores, the peridium being quite hyaline.

It is a difficult task to decide in which family Heleococcum (and Testudina) are to be included. When following the classification of Ed. Fischer in Engler & Prantl "Natürliche Pflanzenfamilien" I, 1, 1896, both forms have to be classed among the Plectascineæ, to which Ed. Fischer refers the families Gymnoascaceæ, Aspergillaceæ, Onygenaceæ, Elaphomycetaceæ and Terfeziaceæ, the common feature of which is that the asci lie promiscuously in the ripe perithecium.

Heleococcum cannot however be included in any of these families. It certainly approaches to the Aspergillaceæ in the structure of its perithecium, but differs in its two-celled spores and in the fact that conidia are entirely wanting.

I prefer therefore, as Clements in his "Genera of Fungi" 1909, to consider the Perisporiaceæ more comprehensively and to include the Aspergillaceæ in this family, being recognizable by its globular, membranaceous or coriaceous perithecia without any apical pore. Heleococcum is then naturally placed in this family, where it together with Testudina forms a connective link between the Aspergillus (Eurotium) on the one hand and the typical Perisporieae on the other.

The ripe ascospores already germinate in 24 hours after being sown in a hanging drop of sweet wort (Fig. 2 a). When the germination takes place at a rather low temperature in which the development of bacteria in the culture is repressed, while the fungus is not affected, large myceliums can grow out. They consist

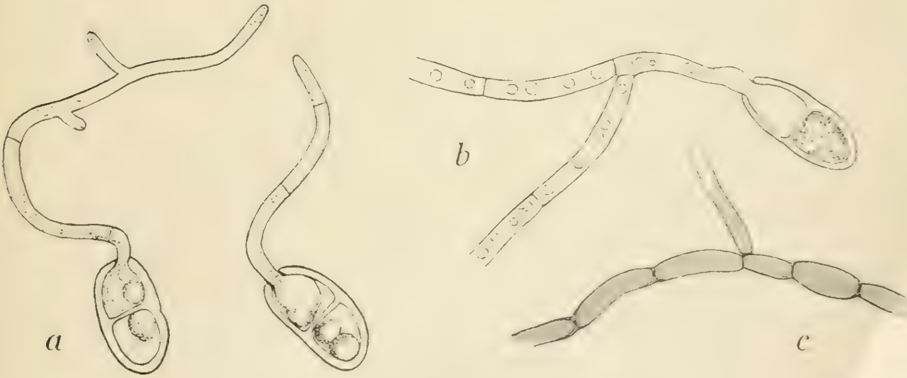


Fig. 2.

a) Germinating ascospores (× 650). *b)* Threads of mycelium with series of oil drops (× 650). *c)* brownish, swelled cells of older mycelium.

of hyaline, cellular, branched, 5—8 μ broad hyphæ, containing a series of bright drops of oil (Fig. 2 b). Older hyphae of the mycelium become brownish and the cells swell slightly (Fig. 2 c). In spite of repeated experiments in transferring mycelia to wort-gelatine and sterile earth, I have not succeded in obtaining perithecia in my cultures.

Bianco Lunos Bogtr. Kbhvn.